VOLUME 85 NO. PL3
OCTOBER 1959
PART 1

JOURNAL of the

Pipeline Division

PROCEEDINGS OF THE

AMERICAN SOCIETY
OF CIVIL ENGINEERS

VOL. 85, PL3 — ASCE PIPELINE DIVISION — OCTOBER 1959

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This Journal is published by the American Society of Civil Engineers. Publication office is at 2500 South State Street, Ann Arbor, Michigan. Editorial and General Offices are at 33 West 39 Street, New York 18, New York. $4.00 of a member's dues are applied as a subscription to this Journal.

Subject and author indexes, with abstracts, are published at the end of each year for the Proceedings of ASCE. The index for 1958 was published as Proc. Paper 1891; indexes for previous years are also available.

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Journal of the

PIPELINE DIVISION

Proceedings of the American Society of Civil Engineers

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Journal of the
PIPELINE DIVISION
Proceedings of the American Society of Civil Engineers

DEWATERING PIPELINE COAL SLURRY[a]

Clarence A. Dauber[1] and Neal F. Gill[2]

ABSTRACT

This paper describes the design of the dewatering and drying facilities for the first successful long distance coal slurry pipe line transportation system. It also reviews the experiences of initially placing the facilities into operation together with the first year's results. The facilities are unique because of the fineness of the product processed. Possibilities of application by others are also discussed.

History

The inflationary trend since World War II has affected The Cleveland Electric Illuminating Company the same as others. The prices of labor, materials, and services which are required to produce its main product — electricity — have been rising constantly.

Fortunately, sales of power have expanded along with the rises. During the past decade, the energy sold has more than doubled. The increased volume resulted in cost savings. For a long period, the Company was able to offset the rising costs with the lower charges resulting from greater production and higher efficiencies.

Unfortunately, the cost increases eventually accelerated more rapidly than the savings. When the turn occurred, it was necessary to find means to reduce costs further, or obtain a rate increase. Inasmuch as the latter was least desirable and not wholesome unless the costs were a minimum, an all-out effort was made to find further savings.

Note: Discussion open until March 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2203 is part of the copyrighted Journal of the Pipeline Division, Proceedings of the American Society of Civil Engineers, Vol. 10, No. PL 3, October, 1959.

a. Presented at the May, 1959, Convention in Cleveland, Ohio.

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Since the largest item of expense is for coal, it received considerable attention. The freight component was found to be rising inordinately. As a result, ways and means to reduce this charge were explored.

The Consolidation Coal Company, the largest coal producer in the United States, was also seeking means to overcome a mounting competitive handicap from gas and oil, imposed by rising freight charges. They discovered through research and development, that pumping coal through a pipe line had potential. This led to seeking a partner in a full-scale venture, the partner to be a major consumer.

Economic studies indicated that The Cleveland Electric Illuminating Company's freight costs could be bettered substantially by the installation of a line between one of its plants and the Hanna Division mines of Consolidation Coal Company. This led to negotiations which resulted in considerable further research and development, and finally, a contract between the two to build and operate a system to be known as Georgetown-Eastlake Pipe Line.

The contract required the Consolidation Coal Company to carry on the development, financing, and construction. The major responsibility of The Cleveland Electric Illuminating Company was to accept the output from the line for a period of fifteen years. In addition, The Illuminating Company was to operate the dewatering and drying facilities during this period. The utility company's engineers were to participate in the layout, arrangement, and selection of the facilities, which were to be located on the power company's site.

Description of Facilities

The dewatering and drying plant is a major component of the Georgetown-Eastlake coal pipe line. The product as received at the end is unburnable until processed. Furthermore, it imposes limits on the material pumped and the pumping operations. In addition, a substantial portion of the overall cost is chargeable to the end treatment.

The facilities are located on the Eastlake Power Plant site where all the coal received is consumed. The arrangement of equipment permits feeding the end product directly into the power plant without costly rehandling.

The Eastlake Power Plant is part of The Illuminating Company's system. It is a 670,000 kw thermal-electric generating plant. The site is on the south shore of Lake Erie, approximately 25 miles east of downtown Cleveland.

The main equipment consists of three (3) 140,000 kw turbo-generators and one (1) 250,000 kw machine. Each has its individual, pulverized coal fired steam generator.

The total coal requirements of the plant approximate 1.5 million tons per year. The daily burn varies. Some days it is as high as 5,900 tons, whereas on weekends and holidays — when the demand for electric power is at a low ebb — the needs will be as low as 3,900 tons. At times it is necessary to drastically curtail shipment because a main generating unit may be off for maintenance purposes.

In order to be economical, the entire transportation system must operate almost continuously. Even the separating process is on a 24-hour, seven-day basis. Inasmuch as there are only a few hours of storage in tanks and bins, the output must approximate the requirements for power generation. Furthermore, the fineness of the product prohibits normal coal pile storage.

Even though there are many coal drying plants, this particular installation

is unique, and will continue to be unique. No other known plant has this particular arrangement of equipment. It was designed to process all fine coal, 100% through number 14 mesh and 20% through 325. Many of the features will never be incorporated in another installation because experience indicates that many items can be eliminated.

The dewatering and drying plant has many features of a sewage sludge processing unit. It has thickeners, clariflocculators, vacuum filters, and dryers.

The equipment arrangement and process sequence is shown on the diagram, Exhibit "A." The slurry leaving the line can take one of three paths. Normally it flows into one of two 90-foot diameter × 16' 6" deep thickeners. Each thickener is equipped with three triangular rake arms which can be raised 24".

The coal-water mixture can also be sent to a 100,000-gallon tank. This tank will accommodate approximately three hours' flow. It is equipped with a propeller-type mixer to agitate the slurry. When it is necessary to disrupt the dewatering or drying operations temporarily, the coal and water is stored in this tank. Also, when surges occur in the pipe line, the tank assists in absorbing the excess or furnishing the deficiency in flow. This prevents disrupting the drying operations.

If it is necessary to stop the dewatering-drying operations for a long period of time, the pipe line flow can be diverted into a storage pond. The pond has sufficient capacity to store the amount of slurry in the entire pipe line. This permits flushing with water before ceasing pumping.

The slurry in the thickeners, consisting of 50% coal and 50% water by weight, normally is pumped to three of the four 10'-6" diameter × 13 disc, vacuum filters. The mixture can also be recycled to the thickeners. This provides agitation of the mixture in the thickeners. This is desirable during the period of starting drying and when operations must cease.

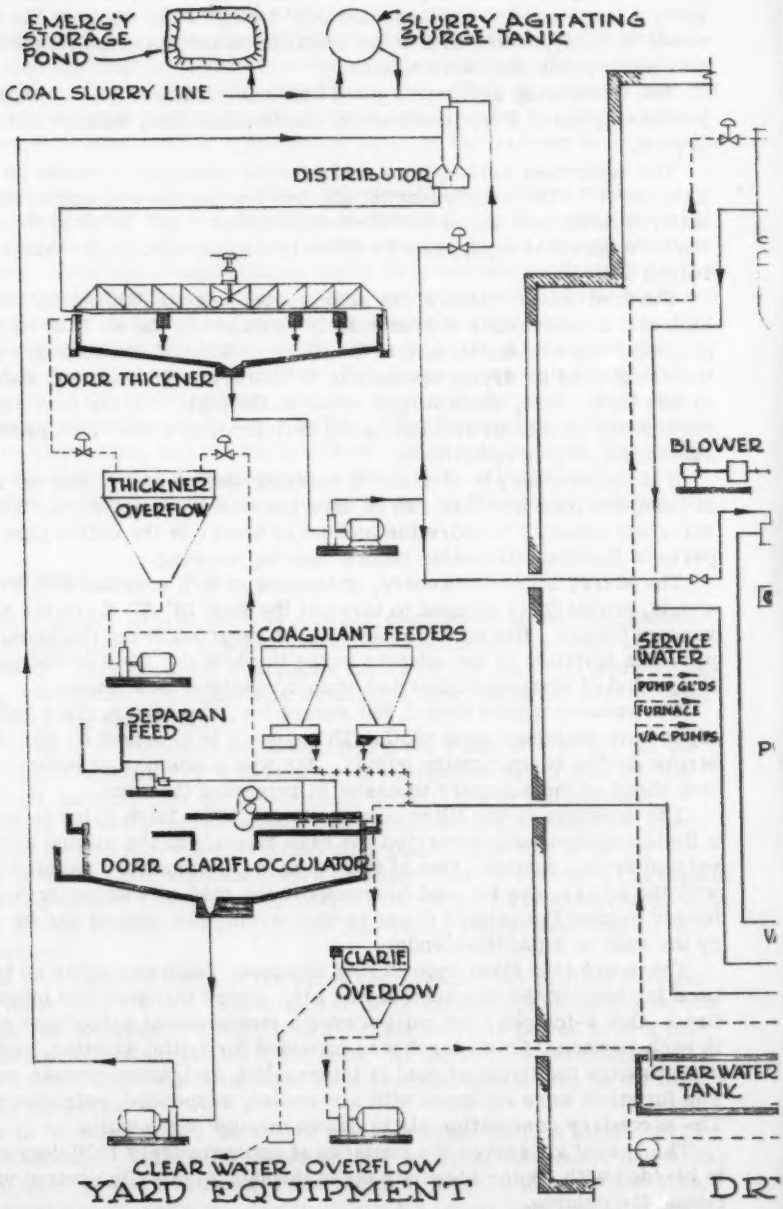
The vacuum filters have 1,950 square feet of active surface each. The discs have stainless steel cloth. The vacuum is provided by four 34/34 × 14" stroke double reciprocating pumps. Air with a positive pressure is introduced just ahead of the scrapers to assist in removing the cake.

The moisture in the filter cake averages 20%. Each filter is equipped with a flight conveyor which carries the cake directly to the mixing screw of its related drying column. One of two other flight conveyors running crosswise with the filters, can be used to transport the cake to another drying column feeder in case the related dryer is shut down. The second can be used to carry the cake to a paddle-blender.

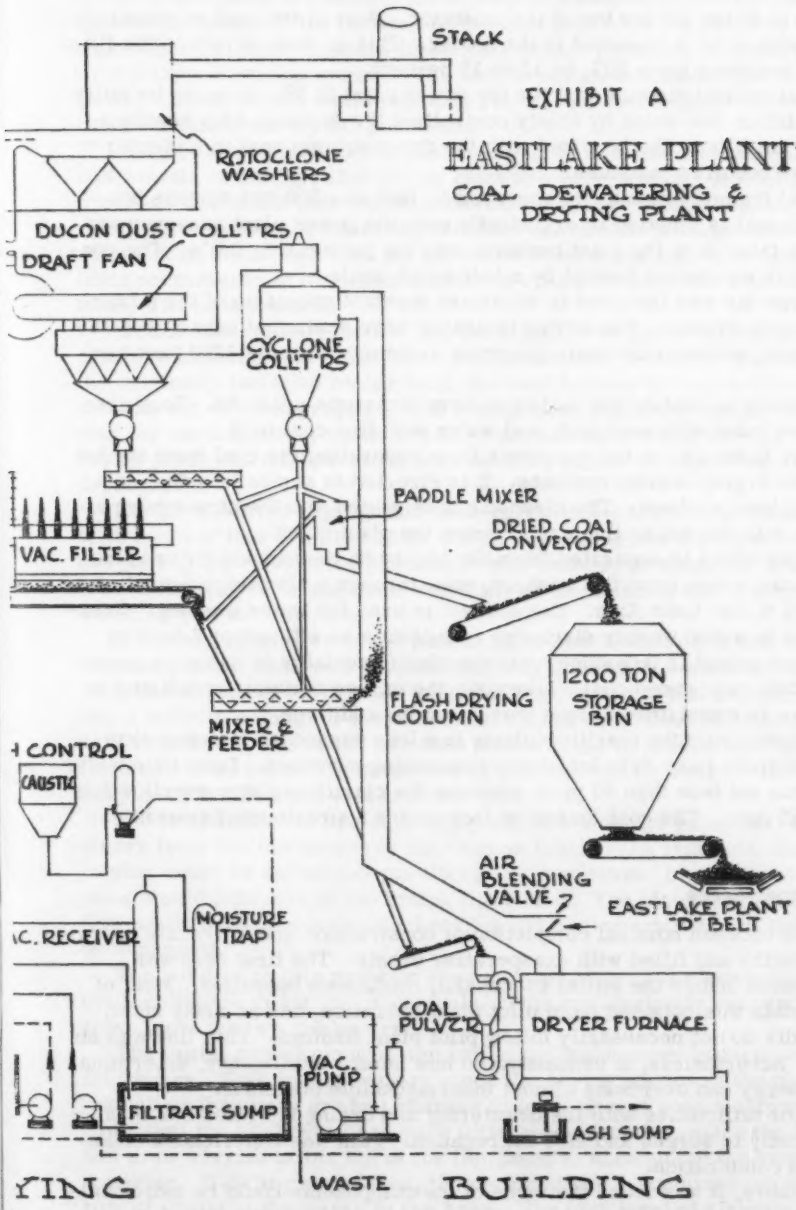
There are four flash-type drying columns. Each two columns have a furnace for heating the required drying air. These furnaces are pulverized coal fired. One 5-ton per hour mill serves a single radial pulverized coal burner in each furnace. An oil torch was provided for initial starting, and to prevent puffs in case the firing of coal is interrupted, or ignition ceases momentarily. The furnaces were equipped with air-cooled, suspended, refractory walls. The secondary combustion air is drawn through these walls.

The heated air leaves the furnaces at approximately 1600 degrees F. This is blended with cooler room air taken through a butterfly control valve preceding the column.

The 950° F heated air drawn upwards through the 3' inside diameter × 44' high column picks up the cake coal fed into the bottom of the column. During the passage, the moisture is evaporated.



YARD EQUIPMENT


STACK
EXHIBIT A
EASTLAKE PLANT
COAL DEWATERING & DRYING PLANT
ROTOCLONE WASHERS
DUCON DUST COLL'TRS
DRAFT FAN
CYCLONE COLL'TRS
PADDLE MIXER
DRIED COAL CONVEYOR
VAC. FILTER
1200 TON STORAGE BIN
FLASH DRYING COLUMN
MIXER & FEEDER
CONTROL
CAUSTIC
AIR BLENDING VALVE
EASTLAKE PLANT "D" BELT
MOISTURE TRAP
COAL PULVZR
DRYER FURNACE
VAC. PUMP
FILTRATE SUMP
ASH SUMP
WASTE
BUILDING

The moist gas-coal mixture from the column is drawn through a 16' diameter cyclone collector. The 4% moisture coal drops to the bottom, and the moist gas is drawn off the top of the collector. Part of the coal is recycled to the column after it is mixed in the feeder. This is done to reduce the filter cake feed moisture from 20%, to 12 to 15 percent.

The desired moisture of coal for the power plant is 9%. It would be difficult to maintain this value by solely controlling the dryers. As a result, a portion of the filter cake is mixed with the dryer column coal in a blender to produce the required moisture.

The coal from the blender is conveyed by belt to a 900-ton storage bin. The stored coal is emptied intermittently onto the power plant conveyor system, which takes it to the plant bunkers over the pulverizing mills. The conveyed coal is weighed in transit by a belt weigh scale.

The surge bin was installed to eliminate constant operation of the power plant conveyor system. The drying facilities have a nominal capacity of 150 tons per hour, whereas the main conveyor system can handle 1200 tons per hour.

The dewatering and drying facilities have two waste products. They are moist gases laden with coal dust, and water with fine coal in it.

The dust-laden gas is the byproduct from separating the coal from the hot gases in the drying column cyclones. It is directed in series into dust collectors and then washers. The cleaned gas is vented into the atmosphere after mixing with the boiler flue gas entering the plant stack.

The water which is separated from the slurry by the vacuum filters plus the dust-laden water from the washers, pass through a clariflocculator before discharging it into Lake Erie. The effluent is used for water washing. Caustic is added to water washer discharge to maintain an effluent of 7.0 pH or better. A coagulant is introduced into the clariflocculator to assist in coagulating the fine, suspended coal. Likewise, the oxygen inhibitor remaining in the overflow is maintained at less than 1 ppm by additives.

The effluent from the clariflocculator has less suspended material than water taken from Lake Erie for steam condensing purposes. Lake Erie water normally has not less than 60 ppm, whereas the clariflocculator overflow has from 5 to 25 ppm. The coal losses by this means approximate 5 pounds per hour.

Starting Experiences

The time between nominal completion of construction and full-scale operation was lengthy and filled with exasperating events. The first coal was pumped months before the initial successful, continuous operation. Most of the design data was obtained from pilot plant operation, and as many know, actual results do not necessarily follow pilot plant findings. This line was no exception. Nevertheless, it demonstrated how human intelligence, determination, and energy can overcome almost insurmountable obstacles.

The major difficulties with the dewatering and drying facilities can be attributed mostly to surges and size segregation. This was experienced singularly and in combination.

Furthermore, it was found that none of the components could be individually operated successfully. In order to insure troublefree performance, the entire system had to be properly synchronized. A miscue anywhere in the chain would disrupt the functioning of almost everything following.

The physical characteristics of the coal received from the line are different from the samples obtained from the pilot installation. Whereas attrition apparently broke off the corners of the coal particles and rounded them into small spheres, there appears to be little of this phenomenon occurring in the Georgetown-Eastlake system. The coal granules are larger and angular. Further investigation would probably reveal that these differences would account for dissimilarity in operations.

Coal dewatering and drying plants are quite common and the individual components of the pipe line drying plant are very familiar to coal processors. However, due to the extreme fineness of the coal to be handled, the arrangement, performance, and starting troubles are probably unique and worthy of comment in connection with the operation of such a plant. The major problems encountered in the initial phases of operation together with their solutions, will be discussed.

Almost immediately on starting the plant, segregation of coarse and fine coal was experienced. The major problems occurred in the thickeners. With the originally installed center feed, the coal formed in a cone-like shape with the coarser coals segregating and rolling down the outer edges. The provision for recirculation, while helpful in preventing settling of coal when the drying plant was not operating, was not fully effective in preventing this segregation.

The ill effects of segregation were particularly felt in the vacuum filters. With a run of fine coal, the filter cloths would plug and air flow — an essential part of the dewatering process — was reduced or stopped. With coarse coal, a filter cake on the cloth was difficult to maintain and again, the dewatering was not effective.

A number of failures of the plastic cloth also occurred at this time. The original plastic cloth was economically replaced with a stainless steel type.

It became apparent that for successful operation of the dewatering apparatus, a definite combination of fines and coarse coal must be maintained. To accomplish this, the number of feed points to the thickener was increased from one to three, and these placed at 120 degrees on a circle fifteen feet away from the original center distributor.

The two thickeners are each equipped with a sludge pump to transport the slurry from the thickeners to the vacuum filters. As installed, this resulted in what could be called non-parallel pump operation. In other words, one pump would take almost the entire filter feed. The other line with very little flow would plug, hence one thickener would be inoperative until the line could be unplugged.

The solution to this problem required metering of the individual flows and the installation of automatic controls. This satisfactorily resulted in even flows from the two thickeners.

The initial drying plant design called for some surge capacity in the thickeners. This was necessary since the drying portion of the plant cannot take other than very gradual changes in load. It was soon discovered, however, that the thickeners had very little surge capacity, since the slurry level had to be carried at the top of the thickener to accomplish the required dewatering. With any surge then, the decanted water contained too high proportion of solids to discharge to the Lake. The high level of slurry also resulted in an overload on the rake motors with consequent poor mixing.

Subsequently then, the level in the thickeners was dropped so they could act as limited surge capacity and provide better mixing. To provide for large

surges, such as would occur if there was an interruption of the drying plant, a 100,000-gallon surge tank was installed ahead of the thickeners.

These changes provided adequate surge capacity and satisfactory size mixture. The expected 5% dewatering capacity of the thickeners is not obtained, however.

Since the thickeners accomplish very little dewatering and alone are not fully effective as surge tanks, it seems reasonable to assume they would be eliminated in any future installations.

Continuing through the cycle, we find that not all troubles were confined to the so-called dewatering equipment. The initial furnace operation, supplying hot gases for the drying column, was very erratic. Tests and analyses indicated the reason for this was an unexpectedly high ash (19%) and low Btu coal feed from the secondary dust collectors. This high velocity equipment was apparently collecting the larger particles which were high in ash. To provide an acceptable furnace coal feed, some of the product feed from the primary cyclone collector was mixed with that from the secondary collector. This mixture gave a uniform and satisfactory coal that could be burned without any extensive furnace redesign.

Another limitation in the drying equipment is that it overloaded if the final moisture is over 4%. Since it is highly desirable to be able to control moisture between 5 and 9 percent, some solution to this problem was necessary. Any change in the drying equipment to provide moisture control appeared to be rather expensive. Blending of a high-moisture coal with this dry coal seemed like a practical solution. A paddle-type mixer was installed. Input to the tank consists of approximately 25% vacuum filter cake and 75% dry product from the drying column. This has provided a satisfactory final product.

In design calculations it was assumed that the dried coal would weigh 50 pounds per cubic foot. Actually it weighs about 40 pounds. Hence, the end product surge bin holds not 1,200 tons, but only approximately 900. It is necessary to resort to more frequent unloadings than anticipated.

Problems in Power Plant with Pipe Line Coal

The foregoing problems and their solutions cover the major ones occurring in the coal preparation plant. However, the unusually fine, hot 180°F) dry coal (5% moisture) intensified and created problems as it was being transported by the conventional belt conveyors to the coal bunkers in the main unit generating plant. The leakage at the skirts of the conveyor chutes became intolerable, requiring extra men to clean up the coal dropping from the belts. Dust created at transfer points of the belt became a matter of concern. Further, when the weather became cold, the warm, moist vapor from the coal created a very dense fog. This condensed on the cold conveyor gallery surfaces and building ceilings. The drippings from the surfaces were like rain. Where it was below freezing, ice collected.

Installing seals rather than conventional skirts on the ends of coal belt transfer chutes effectively decreased the leakage. Also, raising the moisture from 5 to 9 percent significantly improved the dust problems. A collecting system to remove the dust and moisture-laden air at the belt conveyor transfer points is being installed. The space above the coal bunkers will be heated. These steps, it is expected, will give satisfactory conditions along the conveyor.

Main Unit Stacks

Coal received from the pipe line has an ash content, some 3% better than that for other coals received from this area. This is due to cleaning at the source. Hence, the dust loading of gases leaving the stack is somewhat lower than for coals received by truck or rail. However, the stacks appear dirtier. This is accounted for by the following three factors:

1) Fine dust appears darker than coarse particles
2) Coal particles from the washers blacken the plume
3) Added moisture from the drying plant creates a denser plume

In addition, the moisture from the drying plant condenses as it passes through the colder discharge ducts. This highly acid water has to be continually removed at the stack base.

While total solids leaving the stack are no worse than prior receiving of coal by pipe line, every effort is being made to improve the stack appearance.

Performance

In general, the performance is better than originally anticipated. The actual coal that can be transported is greater than was expected. The system is more flexible than hoped. Although many costs exceeded the original estimates, the overall savings were very close to the study calculations.

During the past twelve months, 1,290,000 tons of coal were transported through the line. The monthly receipts are shown on Table I. Inasmuch as many alterations were still being made in the earlier months, which required extended shut-down periods, the quantities handled were not as great as in the latter months. With the changes completed, it is anticipated that 1,500,000 tons will be received during the coming year. This is approximately 100% of the power plant requirements.

The actual maximum capacity is approximately one-third greater than the design figure. Two hundred tons per hour are obtainable, whereas 150 was the design base. Average performance is 172 tons per hour.

Another quality not anticipated was the flexibility. By orderly adjustment, the load-carrying ability of the line can be varied from 130 to 200 tons per hour. This enables the operators to match the coal receipts from the line to the plant requirements. Inasmuch as there is not a large amount of storage capacity, which could be used to even out the peaks and valleys of the power plant needs, it has proved to be a valuable feature. Also, the ability to load the system to 200 tons per hour has practically eliminated the need of receiving fuel by other means. The original intent was to obtain 80% of the plant requirements through the line, and obtain the peak requirements by other modes of transportation.

The product received is of a higher quality than obtained through previous normal channels. The coal received prior to the use of the line approximated 12,100 Btu, whereas the average pipe line product is 12,200 Btu. The ash content is 9% compared to 12%. Processing the coal through the dewatering and drying facilities does not appear to degrade its quality. Although the temperatures in the drying columns are in the vicinity of 950°F, there is no indication of loss in volatile. Our latest tests indicate that approximately 3% of the coal received is used for drying purposes.

The overall savings achieved through the use of this pipe line are approximately what were anticipated. Although the cost of installation exceeded the estimate, the increased tonnage available more than offset the higher costs.

TABLE I

MONTHLY COAL PIPE LINE COAL RECEIPTS

(5% Moisture Coal)

	Tons	Tons/Hour
1958:		
April	63,500	88.19
May	82,929	111.46
June	99,792	138.60
July	107,061	143.90
August	117,713	158.22
September	126,766	176.06
October	117,574	158.03
November	114,976	159.69
December	125,489	168.67
1959:		
January	120,371	161.79
February	97,796	145.53
March	115,206	154.85
YEAR ENDED MARCH, 1959	1,289,173 Tons	147.17 Tons/Hour

Future Possibilities

In the future, the coal pipe line should prove more economical. This will be due to the operating and maintenance labor component of the pipe line being much less than that of the usual methods of transportation. Most of the pipe line costs are fixed and will not be affected by inflation.

Any future pipe lines should cost relatively less than this initial one. The development costs, which were a substantial amount in this case, should be practically zero. Some items of equipment could be eliminated. For instance, there is a possibility of burning filter cake without further drying. The main difficulty would be to transport the filter product to the coal-burning facilities.

A longer pipe line would be more economically favorable. Approximately one-half the costs of a system is in the preparation and the dewatering and drying facilities. No matter how long this line would be, the latter costs would be the same. As a result, the ton-mile cost should lower for a longer line.

A larger capacity line should be economically more favorable. The unit

costs would be less because, normally, the price of larger sized equipment does not increase in proportion to the increase in size. For instance, the right-of-way costs for the line would be the same. In addition, less metal is used in the pipe for the larger diameter line. Also, the operating labor requirements would be the same for a larger size.

In view of the fact that power plants will be larger in the future, the increased fuel requirements will make coal pipe line transportation more favorable. Experience up-to-date indicates pipe lines are reliable and can be made an integral part of the power plant. This should result in consequent savings. Unless other modes of transportation find effective means to lower rates, you can expect more such lines to be built in the future.

CONCLUSION

The past year's experience indicates that the Georgetown-Eastlake coal pipe line is a successful installation. There are many reasons for this. For instance, the overall delivery performance is better by some 30% than originally anticipated. The cost reduction objective was met. If inflation continues, the results will be still better.

If another such line is constructed, it could be done relatively cheaper. Many of the features incorporated in the initial one could be omitted. Also, in some cases, less costly items could be substituted.

The initial line was adapted to an existing power plant, whereas if both the power plant and the line were constructed together, the equipment could be more compatible.

A general statement that coal pipe lines will replace all other modes of transportation in the future cannot be made. The success of such a venture depends entirely upon individual circumstances. In the first place, there must be a source of coal which will provide large quantities at a single location. Secondly, this coal should be all consumed at the receiving end of the line. Any future handling will add too much to the cost of transportation. The distance between the origin and the point of use has an important bearing on the feasibility. If there are no existing facilities, the chances of the pipe line being successful are greater. Where other modes of transportation can be used, the rates established by them will determine whether or not a pipe line will be economically feasible. In other words, each individual installation has to be considered on its own merits.

ACKNOWLEDGMENTS

The authors wish to express their appreciation for the assistance given by Mr. Victor D. Hanson, Chief Mechanical Engineer of Consolidation Coal Company, and Mr. Gordon H. Walker, Senior Power Engineer of The Cleveland Electric Illuminating Company. Both contributed extensively to the preparation of this paper.

Journal of the
PIPELINE DIVISION
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REGULATION OF PIPELINE DESIGN AND CONSTRUCTION

Second Progress Report of the Task Committee on Investigation of Problems Involved in Regulation of Pipeline Design and Construction by Various Governmental Agencies of the Committee on Pipeline Planning of the Pipeline Division

ABSTRACT

Development of Canadian oil and gas has resulted in regulation of pipeline design and construction by the provinces of Alberta, British Columbia, Manitoba and Saskatchewan. These regulations, compiled and briefly abstracted, differ from State codes in the United States regulating gas pipelines only, in that they also apply to oil pipelines.

The Task Committee on Investigation of Problems Involved in Regulation of Pipeline Design and Construction by Various Governmental Agencies has compiled and abstracted regulations affecting pipeline design and construction in the United States (Journal of the Pipeline Division, Vol. 85, No. PL 2, May 1959, Part 1).

Discovery and development of substantial oil and gas fields in Canada during recent years has prompted several Canadian provinces to adopt acts regulating the design and construction of pipelines. In general, the acts adopted by Canadian provinces vary from comparable regulations or codes which are currently in affect in 15 states in the United States in that they apply equally to oil and gas pipelines; whereas all State codes now in affect in the United States apply to the transmission and/or distribution of gas only.

The Task Committee has not studied any problems involved by the various regulations currently in affect in the United States and Canada. The Committee has, however, noted that most State and Provincial codes or acts are based upon Section 8 of the American Standard Code for Pressure Piping, ASA B31.1.8-1955 (or earlier editions) with widely varying additional

Note: Discussion open until March 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2204 is part of the copyrighted Journal of the Pipeline Division, Proceedings of the American Society of Civil Engineers, Vol. 85, No. PL 3, October, 1959.

restrictive clauses or modifications. The desirability of uniformity and for the minimizing of additional restrictions on the ASA Code seems obvious.

The following Supplement is a compilation and abstract of regulations presently in affect in the Provinces of Alberta, British Columbia, Manitoba and Saskatchewan:

Province of Alberta
Department of Mines and Minerals
Natural Resources Building
Edmonton, Alberta, Canada

The Pipe Line Act, 1958:

1. Does not apply to:
   a. A pipeline situated wholly within the property of a refinery, processing plant or marketing plant.
   b. A pipeline being constructed or operated by leave of the Board of Transport Commissioners for Canada under the Pipe Lines Act (Canada).
   c. That portion of a distribution system within the boundaries of a city, town or village.
   d. A pipe transmitting gas or fuel oil from a tank that is situated wholly within the property of a consumer, and the installations in connection therewith.
2. Must secure a permit from the Minister of Mines and Minerals and comply with all requirements thereto, including satisfactory pipeline test and furnishing of plan of survey.
3. Approval of highway crossings and parallel occupancy nearer than 100' of centerline of highway and 50' of centerline of road. Erect signs at limits of crossing.
4. Approval for crossing irrigation or drainage ditch.
5. Signs at river crossings.
6. No interference to mine or quarry.
7. Report breaks and amount of leakage.
8. Alter or relocate pipeline, if ordered, however, may be compensated.
9. Operator of pipeline may secure interest over land for pipeline purposes only, by order of Board of Public Utility Commissioners (Condemnation).
10. No code of design and construction in force.

Province of British Columbia
Department of Railways

An Act Respecting Oil and Gas Pipelines
March 15, 1955 - December 10, 1957:

1. Applicant shall make application and furnish maps for certificate to construct a pipeline including description of agreements for purchase, transportation and sale of gas or oil. Publish notice of intention to make application one week prior thereto.

2. Railway crossings in accordance with Rules and Regulations of "Railway Act."

3. Report from inspecting engineer before opening pipeline.

4. Casings with vents required for highway crossings.

5. ASA Code B31.1.8-1955 applies to steel pipe only.

6. All welding shall be in accordance with ASA Code B31.1.8-1955.

7. Gas compressor stations shall be in accordance with ASA B31.1.8-1955.

8. Design, fabrication, installation, testing and inspection of oil transmission line, including welding, shall be in accordance with ASA B31.1.8-1955.

9. Flow lines and gathering lines shall be in accordance with ASA Code B31.1.8-1955.

10. Shall erect signs at both ends of crossings of public highway, surveyed roads, road allowance or railway outside of boundaries of a city, town or village subject to local conditions.

11. Inspection by inspectors of Department of Railways shall be maintained during construction and for final inspection.

12. Fees shall be paid to Minister of Finance for approval of plans and specifications at following rates:

100 miles or less	$40.00 per mile
101 miles to 250 miles	30.00 per mile
251 miles to 500 miles	20.00 per mile
501 miles and over	15.00 per mile
For special inspection upon request	50.00 per day
For shop inspection	10.00 per unit of special fabrication
Shop inspection outside of British Columbia	50.00 per day

13. Operation shall be in accordance with ASA Code B31.1.8-1955 for gas transmission lines and code defined and adopted by Minister for Oil Transmission.

14. Accidents involving death of one or more persons shall immediately be reported to Deputy Minister and investigation may be held.

15. Cannot lay pipe within 6' of previously laid substructures within public streets without consent of owners or municipality.

16. Maintain signs at limits of road or railway crossings outside of municipalities.

17. Shall not interfere with access or operation of mines.

18. Pipeline company shall cut thistles and all noxious weeds growing on right-of-way each year.

Province of Manitoba
Gas Pipelines and Systems
The Municipal and Public Utility Board
Law Courts Building,
Kennedy and Broadway
Winnipeg 1, Manitoba, Canada

Gas pipelines and systems fall under the jurisdiction of the Municipal and Public Utility Board which requires that the design, construction, operation and maintenance of gas pipelines shall conform to the American Standard Gas Transmission and Distribution Piping Systems, ASA B31.1.8-1955.

Oil Pipelines:

Department of Mines and Natural Resources
Mines Branch, Petroleum Engineering Division
Room 2 - 232 Memorial Boulevard
Post Office Box 42, Legislative Building
Winnipeg 1, Manitoba, Canada

"The Pipeline Act" — An Act Respecting the Construction, Operation and Maintenance of Pipelines:

1. Apply for permit to construct pipeline to Minister of Mines and Natural Resources providing plan and information regarding size of pipe and pumping stations and capacity.

2. Minister may authorize entry upon lands for surveys and examinations necessary to establish pipeline site.

3. Minister may order a public hearing respecting the proposed pipeline.

4. Written consent of the Minister of Public Works to construct within 100' of, or cross over or under a highway or within 300' of a Provincial highway.

5. Pipeline permittee may, after endeavouring to acquire by reasonable means and agreement, enter upon lands for construction of the pipeline, not exceeding 60' in breadth, except for pumping stations, etc.

6. Must secure license from the Minister to operate pipelines.

7. The Lieutenant-Governor-in-Council may make regulations governing all phases of the pipeline construction and operation, not inconsistent with any other provision of the Act.

Province of Saskatchewan
Department of Mineral Resources
Regina, Saskatchewan, Canada

The Pipelines Act, 1954:

1. A pipeline under this Act means a pipeline for transportation or conduct of oil or gas, or water incidental to drilling or production of oil or gas.

2. Permit required for construction and operation of pipeline.

3. Application for permit shall contain map of pipeline route, intended size and capacity, location or pumping stations, tanks, reservoirs, etc. Application fee is $25.

4. File copy of application with Minister of Highways and Transportation.

5. Except for highway crossings, this Act does not apply with respect to tanks, tank batteries, surface reservoirs, flow lines, service lines, gathering lines and real property required therefor. The Minister may exempt a pipeline or parts of a pipeline, not exceeding in any one case ten miles in length, from provisions of Act.

6. No alterations or discontinuance of operation of pipeline without authorization of Minister.

7. Provide security for payment of damages and for safety measures.

8. Fix minimum number of and capacity of storage tanks, meters, governors, control valves and the gauging of oil and analysis and testing of oil and gas.

9. Provide sign marking of pipelines at road crossings.

10. No pipeline shall be constructed on, across, over, or under a public highway or within 300' of a provincial highway or within 100' of a public highway, without written consent of the Minister of Highways and Transportation. However, permittee shall have right subject to above to construct, maintain, and operate pipeline on, across, over, or under any public highway.

11. Prescribe maximum pressures to which pipeline may be subjected.

12. Prescribe specifications and minimum standards for pipelines. Standards of construction and operation to be in accordance with regulations prescribed by Department of Labor and where no Provincial standards are available, in accordance with the standards of American Society for Testing Materials.

13. Prescribe treatment of oil or gas and fix types and quantity of oil to be transported in pipeline and prescribe extraordinary measures to be taken in the event of emergency endangering or likely to endanger life or public property.

14. Final fluid or pressure tests shall be run prior to application for operating permit.

15. Minister may inspect all records, pipeline, and equipment at any reasonable time.

16. If operator fences pipeline or other works in connection therewith, he shall destroy all noxious weeds growing on right-of-way each year before they mature to seed.

Respectfully submitted,

Jay Ball
Herbert J. Chapton
Richard Garnjost
Ralph C. Hughes
A. C. J. McLaughlin
Lewis E. Hoffman, Chairman

Journal of the
PIPELINE DIVISION
Proceedings of the American Society of Civil Engineers

BIBLIOGRAPHY ON PIPELINE DESIGN, CONSTRUCTION AND OPERATION

Progress Report of the Task Committee on Compilation of Bibliography of Reference Materials on Pipeline Design and Construction of the Committee on Pipeline Design, Specifications and Operating Standards of the Pipeline Division

ABSTRACT

The Pipeline Division, through a Task Committee, has released a Compilation of Bibliography of Reference Materials on Pipeline Design and Construction. The Committee proposes to issue supplementary information periodically. Interested individuals or organizations are urged to offer their suggestions as to form, content and additional references for further publications.

INTRODUCTION

The Pipeline Division, inaugurated in October 1956, has as one of its committees the Committee on Pipeline Design, Specifications and Operating Standards. The purpose of this Committee is "to investigate and correlate studies of design and specifications of line pipe, fittings, pipeline materials, corrosion control, measurement, construction and operating standards, and to disseminate this information to the profession."

A five-man Task Group was established late in 1957 to develop a bibliography of such reference materials for periodic publication in the ASCE Pipeline Division Journal and ultimate publication as a Technical Manual of ASCE.

The references are separated as to the various fields of activity and show in brief summary the source of information such as Professional Organizations and Technical Committees, Industry Associations, etc. The Organizations and Associations have Journals and Magazines in which articles pertaining to this field of interest are published. The material is so voluminous that

Note: Discussion open until March 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2205 is part of the copyrighted Journal of the Pipeline Division, Proceedings of the American Society of Civil Engineers, Vol. 10, No. PL 3, October, 1959.

no attempt is made to list all papers, articles and books. Engineers desiring additional information should contact directly the addresses indicated in the bibliography.

It is urged that all interested individuals or organizations review the bibliography and offer their criticism and suggestions as to form and content.

Professional Organizations

1. American Institute of Electrical Engineers,
   31 West 39th Street, New York 18, N. Y.
2. American Society for Testing Materials,
   1916 Race Street, Philadelphia 3, Pa.
3. American Institute of Chemical Engineers
   25 West 45th Street
   New York 36, New York
4. American Society of Civil Engineers,
   33 West 39th Street, New York 18, N. Y.
5. American Society of Mechanical Engineers,
   29 West 39th Street, New York 18, N. Y.
6. American Society of Naval Engineers
   605 F. Street, N. W.
   Washington 4, D. C.
7. American Standards Association,
   70 East 45th Street, New York 17, N. Y.
8. American Water Works Association, Inc.,
   2 Park Avenue, New York 16, N. Y.
9. American Welding Society,
   33 West 39th Street, New York 18, N. Y.
10. Association of American Railroads
    59 East Van Buren Street, Chicago 5, Ill.
11. Boston Society of Civil Engineers
    88 Tremont Street
    Boston 8, Massachusetts
12. Federation of Sewage and Industrial Waste Assoc.,
    Washington, D. C.
13. Highway Research Board
    2101 Constitution Avenue, N. W.
    Washington 25, D. C.
14. Manufacturers Standardization Society of the Valve and Fitting Industry,
    420 Lexington Avenue, New York 17, N. Y.
15. National Association of Corrosion Engineers,
    1061 M & M Building, Houston 2, Texas
16. National Fire Protection Association,
    60 Battery March Street, Boston 10, Mass.

17. New England Water Works Association
73 Tremont Street
Boston 8, Massachusetts

Industry Associations

1. American Concrete Pipe Association,
228 N. LaSalle St., Chicago 1, Ill.
2. American Concrete Pressure Pipe Association,
228 North LaSalle Street, Chicago 1, Ill.
3. American Gas Association,
420 Lexington Avenue, New York 17, N. Y.
4. American Petroleum Institute,
50 West 50th Street, New York 20, N. Y.
5. American Railway Engineering Association,
59 East Van Buren Street, Chicago, Ill.
6. Cast Iron Pipe Research Association,
Prudential Plaza, 130 East Randolph Street,
Chicago, Ill.
7. Clay Pipe Sewer Association,
Columbus, Ohio.
8. Portland Cement Association
33 West Grand Avenue, Chicago, Ill.
9. Steel Plate Fabricators Association
105 W Madison St., Room 2105
Chicago 2, Ill.
10. Steel Water Pipe Manufacturers' Association
11. National Board of Fire Underwriters
85 John Street, New York 38, N. Y.
12. Superintendent of Documents,
Washington 25, D. C.

Libraries and Indices

1. A.P.I. Technical Abstracts
American Petroleum Institute,
50 West 50th Street, New York 20, N. Y.
2. Battelle Technical Reviews
Battelle Memorial Institute
50 South King Avenue, Columbus 1, Ohio
3. Carnegie Library
Pittsburgh, Pa.
4. Engineering Index, Inc.,
29 West 39th Street, New York 18, N. Y.
5. Gas Abstracts - Institute of Gas Technology,
17 West 34th Street, Chicago 16, Ill.

6. Industrial Arts Index - H. W. Wilson
950 University Avenue, New York 52, N. Y.

7. John Crerar Library,
Chicago, Ill.

8. Library of Congress,
Washington, D. C.

9. Linda Hall Library,
Kansas City, Mo.

10. Monitor (V. 1, 1956) Monitor Publishing Co.,
Republic National Bank Building,
P. O. Box 476, Dallas, Texas

11. National Petroleum Bibliography (V. 1, 1957)
Box 3586, Amarillo, Texas

Books and Bulletins

1. Natural Gas Pipeline Company of America, Chicago, Ill.
"Between the Lines"

2. ASCE Engineering Manuals such as "Hydraulic Models"

3. Crane Company, 1935
"Flow of Fluids and Heat Transmission"

4. Crane Company, 1942
"Flow of Fluids Through Valves, Fittings and Pipes"

5. Institute of Civil Eng., Ireland - Trans. Vol II, 1890
"Flow of Open Water in Open Channels and Pipes"
Robert Manning

6. ASME "Mechanical Engineering"
"The Flow of Liquids in Closed Conduits"
R. J. S. Pigott, Vol. 55, #8 August, 1933.

7. John Wiley and Sons
"Fluid Mechanics" - J. K. Jenard

8. ASME
"Fluid Meters, Their Theory and Application"
4th Ed. 1933

9. McGraw-Hill
"Fluid Mechanics for Hydraulic Engineers" H. Rouse, 1938.

10. McGraw-Hill
"Fluid Mechanics" R. A. Dodge and M. J. Thompson - 1937

11. McGraw-Hill
"Applied Hydro and Aero Mechanics" L. Prandtl and O. G. Tietjens, 1934

12. McGraw-Hill
"Applied Fluid Mechanics" M. P. O'Brien and G. H. Hickox - 1937

13. Prentice-Hall
"Fluid Mechanics" R. C. Binta - 1943

14. John S. Wiley and Sons
"Hydraulics" King & Wisler, 3rd edition, 1933

15. ASCE Trans. Vol. 76 - 1913
"Hydraulics" - F. C. Lea
"Handbook of Hydraulics" - H. W. King

16. John Wiley
"Hydraulic Tables" Williams and Hazen - 1920

17. McGraw-Hill
"Handbook of Hydraulics" H. W. King

18. ASCE Trans. Vol. 21 - 1889
"Experiments Relating to Hydraulics of Fire Streams"
John R. Freeman

19. ASME - 1929
"Historical Dev. of Hydraulic Researches & Some Noteworthy Hydraulic Laboratories in America" J. R. Freeman

20. D. Van Nostrand
"Hydraulics and Its Application" - A. H. Gibson, 4th Ed.
1930

21. McGraw-Hill
"Hydraulics" R. L. Daugherty - 4th Ed., 1937

22. Henry Holt and Co.
"Textbook on Hydraulics" - G. F. Russell, 5th Ed. 1941

23. Western Society of Engineers
Journal 1920 "Hydraulics of Chicago Sanitary District Main Channel" - Murray Blanchard

24. New England Water Works Association
Journal Dec. 1913 "Loss of Head in Bends" - W. E. Fuller

25. ASCE Trans. Vol. 76 - 1913
"Loss of Head Due to Enlargements in Pipes" - W. H. Archer

26. Bureau of Mines, 1956
Monograph #9 "Flow of Natural Gas Through Experimental Pipe Lines and Transmission Lines"

27. Princeton University Press, 1936
"The Mechanics of Turbulent Flow" - B. A. Bakhmeteff

28. Blackie and Son
"Mechanical Properties of Fluids" C. V. Drysdale - 1925

29. ASCE Trans. Vol. 102, 1937
"Modern Conceptions of the Mechanics of Fluid Turbulence" - H. Rouse

30. Oxford University Press
"Modern Developments in Fluid Dynamics" Vol. I & II
S. Goldstein - 1938

31. U. S. Geological Survey
(Most, if not all of their publications would relate to Open Channel Flow, but should be checked)

32. Royal Society
Phil. Trans. 1882 & 1895, 1883
Osborne Reynolds

33. Blackie and Son
"The Physics of Solids and Fluids" L. Prandtl - 1936

34. Federal Power Commission
Reports

35. H. C. Price Co.
"The Tie-In"

36. ASME - 1935 Bul. #3
"Trans. of the Hydraulic Institute of the Munich Technical Univ."

37. Am. Water Assoc. Proc., 1904
"Water Hammer" by O. Simin

38. 2nd Int. Congress Applied Mechanics - 1926 Zurich
"Ueber Die Ausgebildete Turbulenz"
L. Prandtl (Proceedings)

General

1. American Concrete Pipe Assoc., Chicago, Ill.
Concrete Pipe Handbook - H. F. Peckworth

2. Ingersoll-Rand Co., N. Y.
Compressed Air Data

3. ASME
"Fluid Meters"

4. McGraw-Hill Book Co., N. Y.
"International Critical Tables"

5. MacMillan Co., N. Y.
"The Physics of High Pressure" - P. W. Bridgeman

6. McGraw-Hill Co., N. Y.
"Mechanical Engineers Handbook" - L. S. Marks

7. McGraw-Hill Co., N. Y.
"Applied Fluid Mechanics" - O'Brien and Hickox

8. John S. Wiley
"Soils Engineering" - M. G. Spangler

9. Steel Water Pipe Mfg. Technical Advisory Committee to Committee 8310-B The Water Works Practice Comm. of the AWWA
"Service Life of Steel Water"

10. Steel Water Pipe Mfg. Assoc. - AWWA Journal - Jan. 1948
"Design Standards for Large Diameter Steel Water Pipe" - Walter Cates
Also published by Armco Steel Co.

11. Steel Water Pipe Mfg. Assoc. - AWWA Journal - Jan. 1948
"Design Standards for Steel Water Pipe" - Russell Barnard

12. John S. Wiley
"Soil Mechanics in Engineering Practice" - Karl Terzaghi and R. B. Peck

13. John S. Wiley
"Formulas for Stress and Strain" - Roark

14. Taylor Forge Co.
"Modern Flange Design"

15. Trans. ASME, April 1937, Vol. 59 #3 FSP-59-4
"Formulas for Stresses in Bolted Flanged Connections"

16. "Heating, Piping and Air Conditioning" Series appearing from Nov. 1936 to May 1937, incl.
"Strength & Design of Covers & Flanges for Pressure Vessels and Piping" Jasper, Gregerson & Zoellner.

17. AWWA - Journal - Feb. 1947
"Computation of Flows in Distribution Systems"

18. AWWA - Journal - Aug. 1948
"Determination of Economical Pipe Diameter in Distribution Systems"

19. ASME - Journal - June 1933
AWWA - Journal - June 1933
"Symposium on Water Hammer"

20. AWWA - Journal - Nov. 1939.
"Methods of Calculating Water Hammer Pressures" F. M. Dawson and A. A. Kalinski.

21. D. Van Nostrand Co., Inc., N. Y.
"Strength of Materials" Part II - S. Timoshenko

22. AWWA - Journal - December 1956
"Soil Mechanics and Backfilling Practice" - H. M. Reltz

23. AWWA -
Manual "Design and Installation of Steel Water Pipe"
Russell E. Barnard, Editor
Issued by Sub-Committee 8310 D Water Works Practice Committee (Not yet issued for publication)

24. AWWA - Journal 29: 791 June 1937
"Method of Determining Wall Thickness of Steel Pipe for Underground Service"

25. AWWA - Journal 35: 1457 (Nov. 1943)
"Mechanical Joints for Water Lines" - Elson T. Kinder

26. AWWA - Reprint from Journal June 1955
"Design of Wye Branches for Steel Pipe" - H. S. Swanson, H. J. Chapton, W. J. Wilkinson, C. L. King and E. D. Nelson.

27. AWWA - Journal - June 1956
"Suggested Non-technical Manual on Corrosion for Waterworks Operators" - Lee B. Hertzenberg

28. AWWA - Journal - July 1956
"Trench Excavation and Backfilling" - G. F. Lowers

29. AWWA - Journal - November 1948
"Design of Long Span Self-Supporting Steel Pipe"
G. H. Garrett

30. AWWA - Journal - October 1943
"Field Welding of Steel Water Pipe" - H. A. Price and G. H. Garrett.

31. AWWA - Journal - October 1952
"Soil Temperatures in Water Works Practice."

32. AWWA - Journal - November 1950
"Freezing of Water in Exposed Pipelines" - T. M. Riddick

33. ASA - A 21.1 - 1939
Manual "Computation of Strength and Thickness of C. I. Pipe."

34. NEWWA - Journal - 1933
"Pipe Linings and Friction Coefficients" - Elson T. Killiam

35. NEWWA - Journal
"Prediction of Frost Penetration" - W. Shannon

36. ASCE - Proc. 98:101 - 1933
"Design of Large Pipe Lines" - Herman Schorer

37. Corps of Engineers, U. S. Army, Boston, Mass., 1947
Report on Frost Penetration (1944-1945)

38. Corps of Engineers, U. S. Army, Boston, Mass.
Addendum #1 - 1949

39. Highway Research - 11:168 - 1931
"Discussion on Frost Heaving" - A. Casagrande

40. National Bureau of Standards, Washington, D. C.
Circular C 450 "Underground Corrosion"

41. National Association of Corrosion Engineers, Houston, Texas
"Control of Pipeline Corrosion" - O. C. Mudd

42. American Rolling Mill Company - 1947
Bulletin 47-A "Steel Ring Flanges for Steel Pipe"

43. Boston Soc. Civil Engrs. - Journal - April 1941
"Design of Fabricated Plate Steel Tees, Laterals and Wyes of Large Diameters for the Pressure Aqueduct of the Boston Metropolitan District Water Supply Comm."

44. Factory Mutual Eng. Div., 184 High St., Boston 10, Mass.
Bulletins:
11.88 "Piping For Natural and Mfg Gas"
22.70 "Specifications for Laying Fire Mains"
22.71 "Specifications for Anchoring Fire Mains"
31 "Hydraulic Tables"
21.30 "Flushing Underground Mains"

45. McGraw-Hill - 1943
"Formulas for Stress and Strain" - R. J. Roark

46. Steel Plate Fabrication Association
Bulletins:
1. "Wherever Water Flows, Steel Pipes It Best"
2. "Steel Water Pipe - Economical to Install, Economical to Maintain"
3. "Carrying Capacity of Steel Water Pipe"
4. "Reliability and Resiliency of Steel Pipe"
5. "Bottle Tight Joints"

47. Underwriters Labs.
Special Investigation 888 "Report on Steel Pipe Lines For Underground Water Service."

Respectfully submitted,

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John G. Hendrickson, Jr.
Henry H. List
Francis J. Stastny, Jr.
M. J. Shelton, Chairman

Task Committee on Compilation of Bibliography of Reference Material on Pipeline Design and Construction of the Committee on Pipeline Design, Specification and Operating Standards of the Pipeline Division

Journal of the
PIPELINE DIVISION
Proceedings of the American Society of Civil Engineers

NON-STEEL CYLINDER PRESTRESSED CONCRETE PIPES

S. R. Hubbard,[1] M. ASCE

INTRODUCTION

Various types of pressure pipes for the conveyance of water are commonly in use today throughout the world. Most common of these are pipes made of reinforced concrete, prestressed concrete, steel and cast iron. In many cases, all of these pipes are suitable alternates for a given project. The choice generally depends upon availability and cost of material and labor. Pipe size is also an important consideration.

It is the intent of this paper to set forth design principles for prestressed concrete pipes manufactured without the use of a steel cylinder membrane. This type of pipe is commonly referred to as non-cylinder concrete pipe - prestressed. Its use is common throughout the world.

Prestressed pipes employing a steel cylinder membrane are used extensively in the United States at the present time. Design principles for cylinder and non-cylinder pipes are very much the same: the criterion being that the concrete in the pipe wall shall not be subjected to stresses which exceed safe values when the pipes are in service.

Prestressed concrete pipes are structurally suitable for service in sizes ranging from one foot internal diameter to several feet, although economic aspects may impose different limits in various locations. Internal pressures as high as 500 pounds per square inch have been achieved on test pipes having an internal diameter of 33 inches but design practice generally limits internal pressures to those on the order of 350 pounds per square inch and less as diameters increase.

Design Considerations

Several factors must be taken into account when the design of prestressed pipes is undertaken. These are:

Note: Discussion open until March 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2240 is part of the copyrighted Journal of the Pipeline Division, Proceedings of the American Society of Civil Engineers, Vol. 85, No. PL 3, October, 1959.

1. Vice-Pres., Cen-Vi-Ro Pipe Corp., Shafter, Calif.

(a) Internal and external loads to which the pipes will be subjected.
(b) Stresses in the pipe wall which may occur due to discontinuity of the circumferential wire wrapping near the ends of the pipes.
(c) The type of joint to be used between pipe sections.
(d) Protection of the prestressing wire from corrosion and handling.
(e) End anchorages for the circumferential wrapping wire.

Each of these factors is considered below:

(a) Internal and External Loads

The internal loading to which the pipes are subjected is due to water within the pipes. This loading can be considered as two separate parts:

1. The load due to the weight of the water in the pipe itself. This load imposes bending stresses in the pipe wall.
2. The load which consists of the hydrostatic pressure head measured from the top of the pipe to the hydraulic grade line. This load imposes tensile stresses in the pipe wall.

The external loads to which the pipes are subjected are due to the weight of the earth cover plus dynamic loads, which may be imposed by moving vehicles. These loads impose bending stresses in the pipe wall as well as tensile and compressive stresses.

Deflection of prestressed pipes under load is assumed to be linear. It is general practice, therefore, to determine the tensile stresses due to the hydrostatic pressure within the pipes and then add those stresses resulting from the weight of the water in the pipe, the weight of the pipe itself and those from earth loads and dynamic loads. Stresses resulting from loads other than hydrostatic pressure are subject to usual means of analysis and will be discussed only briefly. It is worthy of note, however, that earth loads are usually of second order in water transmission lines where high internal pressures exist. Such earth loads, however, become important when pipe lines are subjected to no internal pressure under heavy earth fills. In this case, compressive stresses in the concrete core must be given careful consideration. In order to withstand the internal and external loads, the pipe are prestressed circumferentially. Static calculations for the pipe core are as follows. . .

Prestressing is accomplished by imposing elastic deformations in the concrete pipe core opposite to those which can be expected when hydrostatic pressure is applied. An analysis of these deformations is presented below for the pipe core in a "static condition". The term "static condition" meaning the condition of the prestressed pipe before it is subjected to internal hydrostatic pressure.

Basic equations for the stress conditions of the constituent materials, high tensile steel and concrete, are developed. Equations for material stresses, after consideration of a time element that takes into account concrete shrinkage, concrete creep, and steel creep, are given. Finally, a mathematical formulation of the basic equations into a single equation for determining the required steel area is set forth and a sample calculation is given.

The following assumptions are made:

1. The circumferential steel and the concrete act in a common cylindrical surface.
2. The steel and the concrete obey Hook's law.
3. The only acting force is due to the hydrostatic pressure within the pipe.

During the process of prestressing the pipe core, the materials take on elastic deformations. With these deformations is the transmission of stress from the circumferential wire to the concrete core. As the circumferential wire is being applied, it is assumed in the calculations that the section of the pipe core immediately ahead of the wire is not prestressed. This is not true since some of the elastic deformation will be effective ahead of the prestressing wire. The assumption that the section immediately ahead of the prestressing wire is fully prestressed is also not valid since complete deformation has not taken place. The calculated difference between the two assumptions is about ten percent. . . .a conservative correction figure is on the order of five percent.

For a considerable period of time after winding, the pipe wall, and the prestressing wire, continue to undergo changes in stress. These changes are due to shrinkage in the concrete, creep in the concrete and creep in the circumferential wire. The latter two are plastic deformations. The exact value for plastic deformations causing stress losses are not usually known. It is possible, however, in specific cases to test the materials to be used and determine appropriate constants. Values used herein are within the range generally used. Shrinkage stresses are independent of material stresses and if the pipes are to remain filled with water so the concrete is thoroughly saturated, shrinkage stresses may be very small—perhaps even negligible.

In the development of the basic design equations, the following notation is used:

D = Internal Pipe Diameter, Inches

t = Core Wall Thickness, Inches

a_s = Circumferential Wire Area in Section, Square Inches Per Foot of Pipe Length

a_c = Concrete Area in Section, Square Inches Per Foot of Pipe Length

K = a_s/a_c

P_i = Pressure at which Concrete Prestress is Zero Immediately After Winding - Pounds Per Square Inch.

P_o = Pressure at which Concrete Prestress is Zero after Plastic Deformation - Pounds Per Square Inch.

E_c = Modulus of Elasticity of the Concrete Core - Pounds Per Square Inch.

E_s = Modulus of Elasticity of the Circumferential Steel - Pounds Per Square Inch.

n = E_s/E_c

f_s = Stress in Circumferential Wire after Plastic Deformation - Pounds Per Square Inch.

f_{so} = Stress in Circumferential Wire at Zero Compression Pressure P_o - Pounds Per Square Inch.

f_{si} = Stress in Circumferential Wire Immediately after Winding before Plastic Deformation - Pounds Per Square Inch.

f_{sw} = Stress in Circumferential Wire during Winding - Pounds Per Square Inch.

f_c = Compressive Stress in the Concrete after Plastic Deformation - Pounds Per Square Inch.

f_{ci} = Compressive Stress in the Concrete Immediately after Winding before Plastic Deformation - Pounds Per Square Inch.

e = Steel Creep Factor

Δ = Concrete Shrinkage - Inches Per Inch.

Fig. 1 shows the pipe section subjected to internal pressure (P_o).

A transmission of stresses occurs throughout the pipe core during the prestressing process. Prestressing increases the stress in the concrete from 0 to f_{ci} and reduces the stress in the steel from f_{sw} to f_{si}. As stated earlier, this concept is not quite true since the concrete at the place of winding will already be partially compressed by the previous windings. Following the method described, the results will be a little conservative.

The unit deformation in the concrete core and the spiral wire are equal, or:

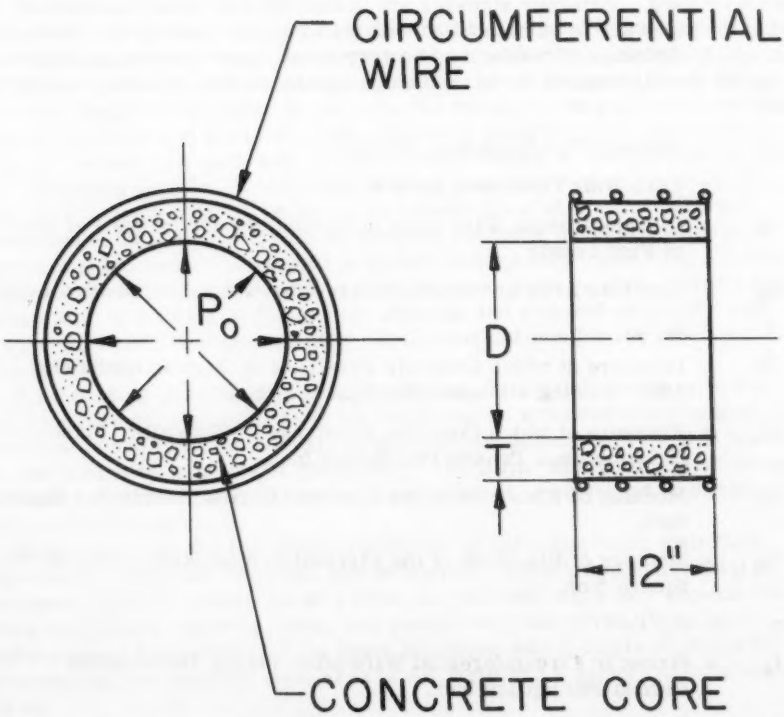


FIG. 1

$$\frac{f_{sw} - f_{si}}{E_s} = \frac{f_{ci}}{E_c}$$

The equilibrium of forces is expressed by:

$$a_s f_{si} = a_c f_{ci}$$

After introducing $a_s/a_c = k$ and $E_s/E_c = n$, it follows that:

$$f_{si} = \frac{f_{sw}}{1 + nk}$$

and. . . . .

$$f_{ci} = k f_{si}$$

When an internal hydrostatic pressure of P_i is applied, a reverse transmission of stress takes place. The prestress in the concrete core decreases and the tension in the circumferential wire increases. When no losses of prestress have occurred, the testing pressure is determined from the equation:

$$P_i = \frac{f_{sw} a_s}{6D}$$

In practice, the actual test pressure is a little lower, as in the short period which elapses between winding and testing some plastic deformation takes place in the steel and concrete. The above equations pertain only at the instant the pipe is prestressed. At this point, concrete shrinkage, creep of the concrete, and creep of the circumferential wire will be taken into consideration.

Concrete shrinkage is denoted by (Δ) and has the units of inches per inch. It is usually on the order of 2×10^{-4} to 4×10^{-4} in./in. It is possible that concrete shrinkage is almost negligible since, in service, the pipe wall remains in a saturated condition. Any appreciable concrete shrinkage need, therefore, be considered only for pipes in a static condition. Tests made on thoroughly saturated pipes indicate that this assumption is conservative and further, that sufficient design accuracy may be achieved by neglecting shrinkage altogether. For completness, concrete shrinkage will be included since the study is based upon pipes in their static condition.

Under the action of sustained stress, concrete undergoes a plastic, or non-elastic, deformation. This deformation, called concrete creep, is attributed to the enclosure of internal voids, viscous flow of the cement-water paste, crystalline flow in aggregates and the flow of water out of the cement

due to the external load. The concrete creep coefficient will be denoted by "c". Many different formulas have been proposed for evaluating concrete creep but none seems to fulfull the requirements of precise mathematical analysis. This is probably due to the fact that there are so many factors involved. Some of these are; kind and type of materials, mix proportions, manufacturing procedures, curing conditions, age of concrete when loaded, magnitude of sustained load, humidity and temperature of surrounding air and size of member. Creep runs an asymptotic course and takes place over a number of years. The time at which the structure is analyzed has a significant effect on the results. The plastic deformation caused by concrete creep is expressed by:

$$\frac{(c-1)\, f_{ci}}{E_c}$$

Where "c" is the concrete creep coefficient, the value of which should be determined by tests if possible. This expression for concrete creep is used in the following development of the basic equations.

The circumferential wire is subjected to creep in the same way as the concrete. Values for creep in the steel are much more readily determined because they are not influenced by so many factors. The steel creep factor is denoted by "e". The plastic deformation caused by steel creep is expressed in the same way as concrete creep:

$$\frac{(e-1)\, f_{si}}{E_s}$$

Values of steel creep coefficient obtained from tests made under constant stress and constant strain for loads near the ultimate strength are about 1.10 to 1.15. Steel creep increases with increased steel stress and it can be reduced appreciably by stressing the wire prior to winding to a value about 10 percent above the winding stress. If winding stresses are below 70 percent of the ultimate strength of the wire, the creep loss in the steel is about 5 percent of the elastic deformation. Tests on the material to be used should be made to determine this value, if possible. A value of 1.05 is used herein.

The steel stress after losses due to concrete shrinkage and plastic deformations is expressed by:

$$f_s = f_{si} - \left[\Delta E_s + (c-1)\, n\, f_{ci} + (e-1)\, f_{si} \right]$$

As stated previously, the unit deformation in the concrete core and the spiral wire are equal, or:

$$\frac{f_{so} - f_s}{E_s} = \frac{f_c}{E_c}$$

The equilibrium of forces is expressed by:

$$a_s f_s = a_c f_c$$

After introducing $a_s/a_c = k$ and $E_s/E_c = n$, it follows that:

$$f_{so} = f_s (1 + nk)$$

and. . . .

$$f_c = k f_s$$

It must be kept in mind that concrete shrinkage, concrete creep, and steel creep have been introduced and when the structure is subjected to an internal hydrostatic pressure of P_o, the static condition of the pipe has changed from that immediately following the prestressing process to that of a considerable period thereafter. The test pressure is, therefore, reduced to:

$$P_o = \frac{f_{so}\ a_s}{6\ D}$$

There are certain design criteria which are known initially and it is, therefore, desirable to develop a mathematical formulation of basic equations involving the known design constants.

The internal diameter "D" and a wall thickness "t" for the core have generally been established. The hydrostatic test pressure, "P_o" is also known. By testing the physical properties of the constituent materials, factors for concrete shrinkage, concrete creep, steel creep, and the winding stress of the circumferential wire can be established. A rearrangement of the basic design equations yields a_s as a function of the design constants; i. e.:

$$a_s = \phi\ (c,\ e,\ \Delta,\ f_{sw},\ P_o)$$

by combining:

$$f_{si} = \frac{f_{sw}}{1 + nk}$$

$$f_{ci} = k\ f_{si}$$

$$f_s = f_{si} - \left[\Delta E_s + (c - 1)\, n\, f_{ci} + (e - 1)\, f_{si}\right]$$

$$f_{so} = f_s\ (1 + nk)$$

$$P_o = \frac{f_{so}\ a_s}{6\ D}$$

We have:

$$n\ a_s^2 \left[\frac{(c - 1)\, f_{sw} + \Delta E_s}{12\ t}\right] - a_s \left[(2 - e)\, f_{sw} - \Delta E_s\right] + 6\ D\ P_o = 0$$

From which:

$$a_s = \frac{6\ t}{Q}\left[R \pm \left(R^2 - \frac{2\ P_o\ D\ Q}{t}\right)\right]^{\frac{1}{2}} \qquad \text{- - - - - - - (1)}$$

Where:

$$R = \left[(2 - e) f_{sw} - \Delta E_s \right]$$

and. . .

$$Q = n \left[(c - 1) f_{sw} + \Delta E_s \right]$$

Equation (1) expresses the required steel area for any given design pressure in terms of initial winding stress while taking into account stress losses due to shrinkage and creep. As an example, consider a pipe having an internal diameter of 33-inches to be designed for a zero compression pressure "P_o" of 325 psi (750 Ft. Head).

D	=	33 Inches	Δ	=	2×10^{-4} in./in.
t	=	2 7/8 Inches	c	=	2.0
P_o	=	325 psi.	e	=	1.05
E_c	=	6×10^6 psi.	f_{sw}	=	130,000 psi.
E_s	=	30×10^6 psi.	a_c	=	12 t = 34.5 sq. in./ft.
n	=	5			

Using Equation (1)

$$R = \left[(2 - 1.05) 1.3 \times 10^5 - (2 \times 10^{-4}) 30 \times 10^6 \right] = 117,500 \text{ psi.}$$

$$Q = 5 \left[(2 - 1) 1.3 \times 10^5 + (2 \times 10^{-4}) 30 \times 10^6 \right] = 680,000 \text{ psi.}$$

$$a_s = \frac{6 \times 2.875}{6.8 \times 10^5} \left[1.17 \times 10^5 \pm \left(1.17^2 \times 10^{10} - \frac{2 \times 325 \times 33 \times 6.8 \times 10^5}{2.875} \right)^{\frac{1}{2}} \right]$$

$$a_s = 0.608 \text{ sq. in./ft.}$$

The tensile stress in the steel at zero compression pressure is:

$$f_{so} = \frac{6 D P_o}{a_s} = 106,000 \text{ psi.}$$

The tensile stress in the steel for no internal pressure is:

$$f_s = \frac{f_{so}}{1 + nk} = 97,400 \text{ psi.}$$

The compressive stress in the concrete for no internal pressure is:

$$f_c = k f_s = 1,720 \text{ psi.}$$

The tensile stress in the steel immediately after winding is:

$$f_{si} = \frac{f_{sw}}{1 + nk} = 120,000 \text{ psi.}$$

The compressive stress in the concrete immediately after winding is:

$$f_{ci} = k\, f_{si} = 2,120 \text{ psi.}$$

The theoretical hydrostatic test pressure immediately after winding is:

$$P_i = \frac{f_{sw}\, a_s}{6\, D} = 400 \text{ psi.}$$

External Loads

The circumferential stresses in the pipe wall due to wire winding and internal pressure are now known. To these must be added stresses caused by external loads and by the weight of the pipe and the weight of the water in the pipe.

There are several methods of computing stresses due to external loads. A common one is that of H. C. Olander of the United States Department of the Interior, BUREAU OF RECLAMATION.(1) Nomograms for stress analysis by the method of Olander are useful in solving earth load problems. Six such nomograms for a 90° bedding angle for the crown, side and invert of the pipe are appended hereto. As an example, consider the 33-inch pipe for which static calculations are given above. Assume the earth cover to be 20 ft. with a density of 100 lbs. per cubic foot. The external vertical load is:

$$\frac{100\,(38.75)\,(20)}{12} = 6,460 \text{ lbs./ft.}$$

Assuming the pipe to be full of water, the bending moment at the pipe invert is (from the nomogram) 15,000 in. - lbs. per foot. The axial force at the invert is 2060 lbs. per ft. compression. Referring to the static calculations for the pipe wall at zero pressure f_c = 1720 psi. To this uniform compressive stress, stresses due to earth loads must be added. The stress at the extreme fibre due to the 15,000 in-lb/ft. bending moment is:

$$S_m = \frac{(15,000)\,(1.437)}{(2.875)^3} = \pm\ 905 \text{ psi.}$$

The uniform compressive stress due to the axial force is:

$$s_f = \frac{2060}{(2.875)\,(12)} = 597 \text{ psi.}$$

The maximum compressive stress in the pipe wall at the outer fiber is then:

$$S_{max.} = 1720 + 905 + 597 = 3,222 \text{ psi.}$$

It is readily seen that concrete having a high compressive strength is desirable. The above calculations are for the pipe invert. Calculations for other sections of the pipe wall are performed as above. The pipe wall should be thoroughly analyzed to be certain that the critical design criteria are met.

(b) Discontinuity Stresses

In order to form the pipe joint in such a way that it will be flexible and watertight, it is often necessary for practical reasons to terminate the circumferential wire wrapping several inches from the end of the concrete core. When this is done, the non-prestressed ends resist the deformation of the prestressed portion of the pipe wall and secondary stresses, or discontinuity stresses, are created. If the circumferential wrap is not terminated close enough to the end of the core, ring cracks occur. See Fig. 2.

Stresses arising from termination of the wire wrapping are more critical as pipe size and pressure head are increased. A rapid reduction in stress occurs as the wire wrapping is brought closer to the end of the pipe. Discontinuity stresses can be precisely analyzed and this should be done in the course of design. Secondary stresses can be reduced to safe values by:

1. Terminating the circumferential wire wrapping as near to the ends of the cores as possible.

Or. . .

2. Providing an effective longitudinal prestress in the cores.

If longitudinal prestressing is employed, some type of end anchorage should be used so the prestress will be fully in effect at the end of the pipe. It is to be noted that secondary stresses are greatest when the pipes are not subjected to internal pressure and that under conditions of service, such stresses are reduced.(2)

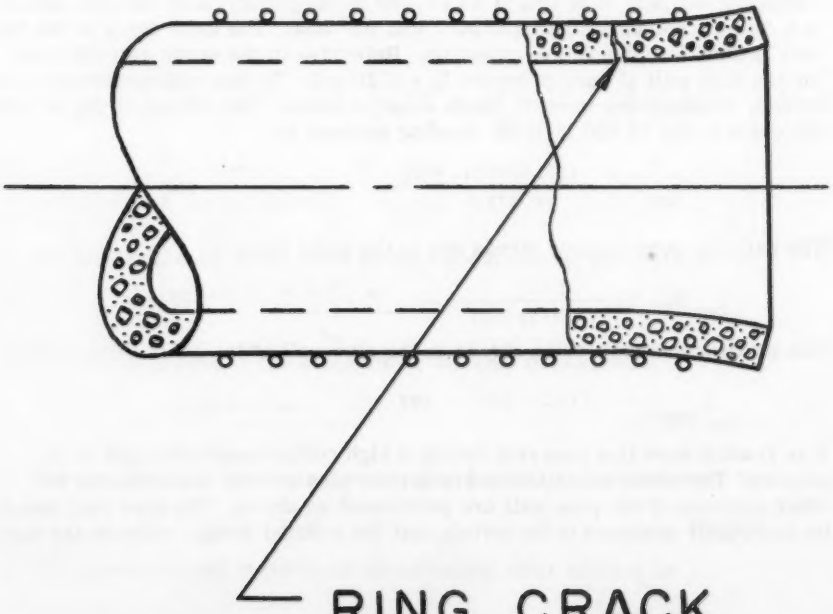


FIG. 2

(c) Type of Joint

The pipe joint must be designed in such a way that allowances are made for expansion, contraction, settlement and lateral displacement in the finished pipe line. Many different joint designs are employed throughout the industry and nearly all of them depend upon some type of rubber gasket as the sealing element. A rubber gasket joint which is properly designed satisfies the requirements set forth above and provides an absolutely watertight seal. A typical rubber gasket joint having concrete mating surfaces is shown in Fig. 3. Water pressure from within the pipes forces the rubber gasket into the small clearance opening in the joint and makes the joint self-sealing.

(d) Protection of the Prestressing Wire from Corrosion

It is general practice in the industry to coat the prestressed pipe core with some type of cement mortar for protection of the prestressing wire.

Conventional methods provide for a coating comprised of approximately 1:3 mix of dry cement mortar. The coating is applied at high velocity with belts or brushes and the resulting protective cover is strong and durable.

Some manufacturers have elected to pour a wet concrete around the core in a steel form that is vibrated. This method requires thicker cover coatings in order that the concrete may be properly consolidated.

The cover coat should be applied as soon as possible after prestressing so that any subsequent deformations of the core will be transferred to the coating giving it a small amount of prestress. Experience has showed that properly applied mortar coating will not crack or chip-off in service and will afford permanent protection for the prestressing wire.

(e) End Anchorages for the Circumferential Wrapping Wire

End anchorages for the prestressing wire shou'd be designed in such a way that the wire will be secured by some type of clamping action. They should also be designed so that the anchor is not in metallic contact with internal core reinforcing, if any is used. The purpose of isolating the end anchor is to prevent the possibility of electrolytic corrosion due to the action of dissimilar metals in contact. The prestressing wire should never be welded or otherwise heated in order to form a connection because this causes the wire to become very brittle and subject to failure.

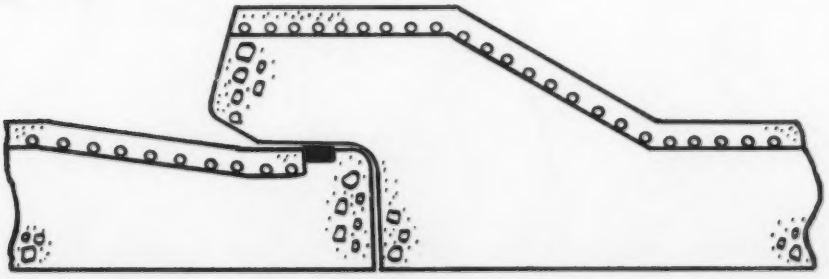


FIG. 3

CONCLUSION

Non-cylinder prestressed concrete pipes will, if properly designed serve indefinitely. If concrete bells and spigots are provided, there will be no possibility of corrosion since there is no exposed metal. Prestressing of the pipe must be done in such a way that safe values of concrete stresses are not exceeded. The procedures outlined herein take time values and accompanying stress losses into account.

The use of non-cylinder prestressed concrete pipes is continually increasing throughout the world, as is the use of prestressed concrete structures in general. It is the responsibility of the engineer to become familiar with the design principles involved since the use of non-cylinder prestressed concrete pipes will inevitably become universal due to economies effected by material savings.

REFERENCES

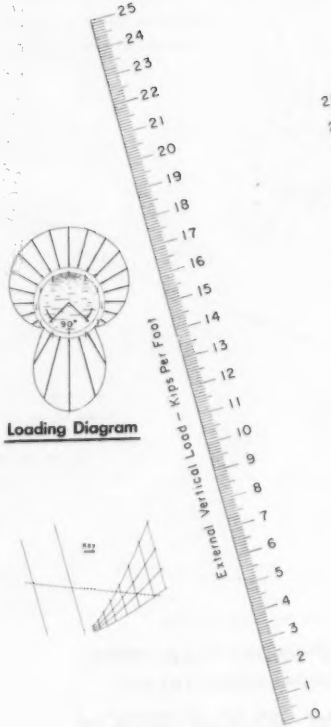
1. H. C. Olander, Stress Analysis of Concrete Pipe Engineering Monographs No. 6 United States Department of the Interior, Bureau of Reclamation, Denver Federal Center, Denver, Colorado.

2. G. A. P. Ooykass, Discontinuity in Prestressed Concrete Pipes Magazine of Concrete Research, No. 9, September, 1951, p. 131, Cement and Concrete Association, 52 Grosvenor Gardens, London S. W. 1, England.

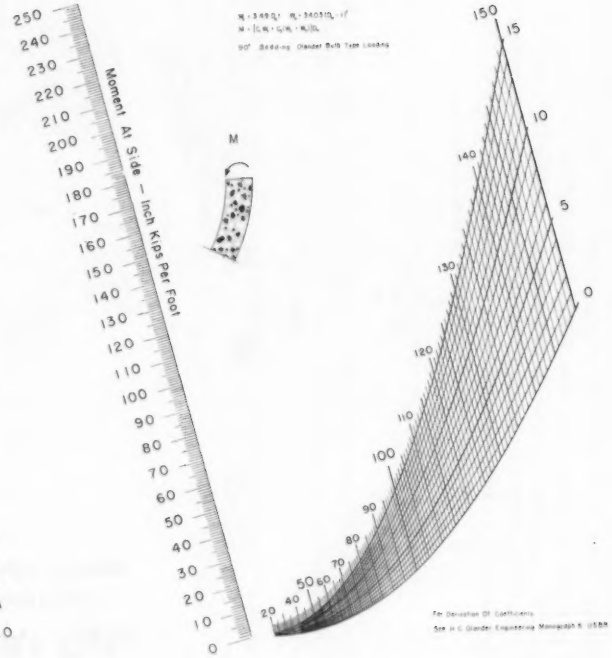
Axial Force At Side
Due To External Vertical Loads,
Weight Of Pipe And Weight Of Water
Compressive Forces Are Positive
Net Force Kips Per Foot
External Vertical Loads – Kips Per Foot
Wall Thickness – Inches
Inside Diameter - inches
24
36
48
60
72
84
96
108
120
132
144
Weight Per Foot Pipe W_p = 3.49 (D+t) t
Weight Per Foot Water W_w = .3403 D²
N = K W_p + K' W_w
N = N + P D
1
2
N
90°
90° Bedding Grinder Rub Type Loading
For Derivation Of Coefficients See H C Grinder
Engineering Monograph 6 USBR
Loading Diagram

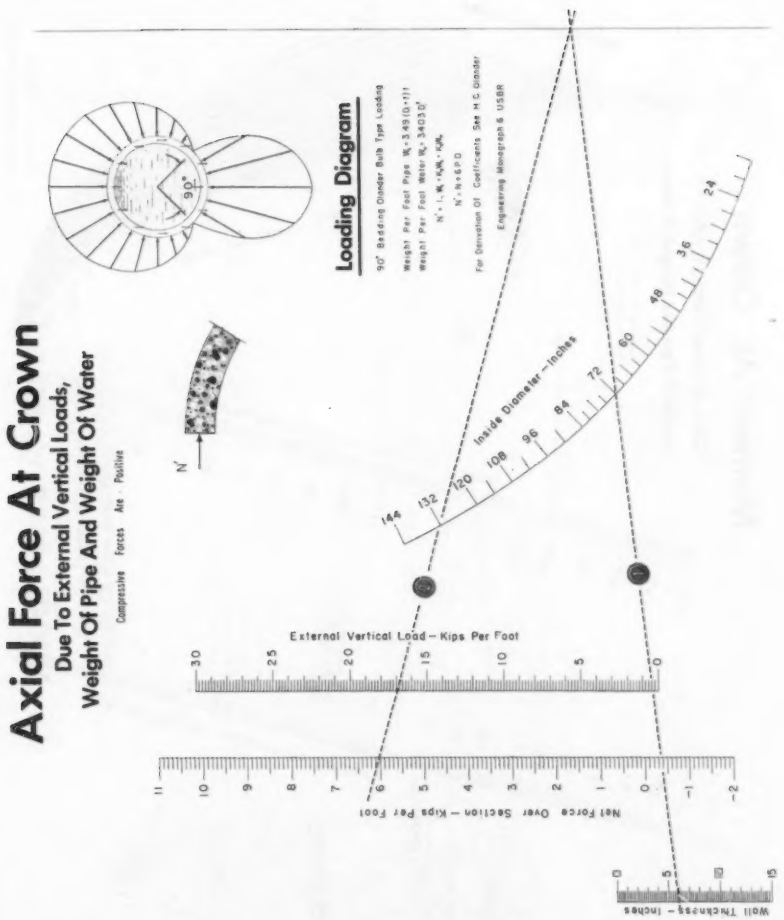
Moment At Side

Due To External Vertical Loads, Weight Of Pipe And Weight Of Water



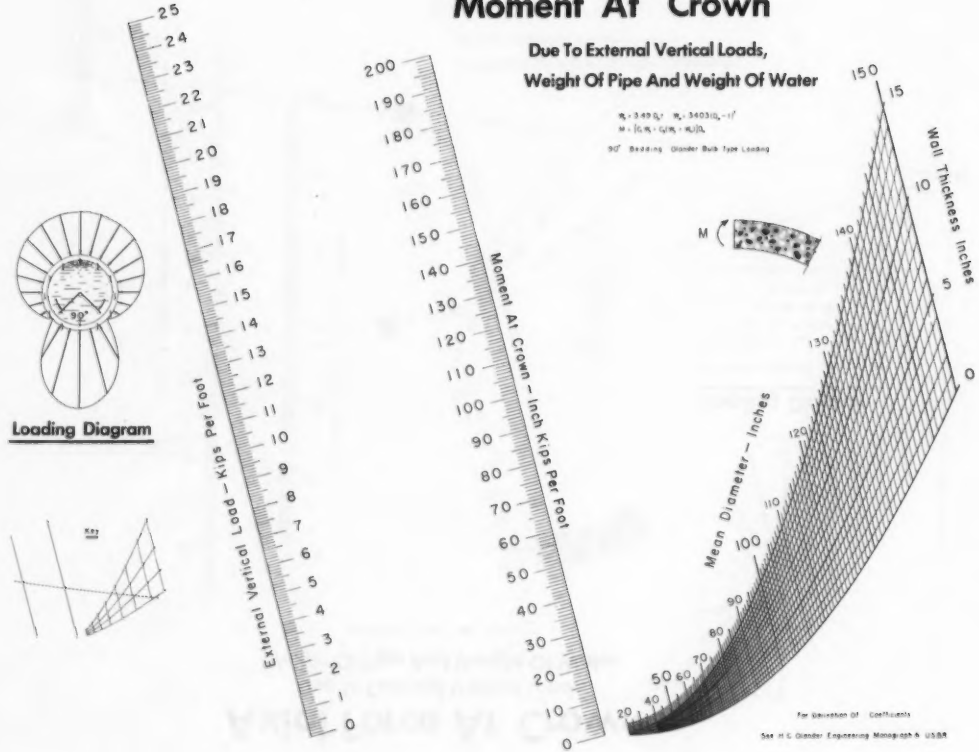
Loading Diagram

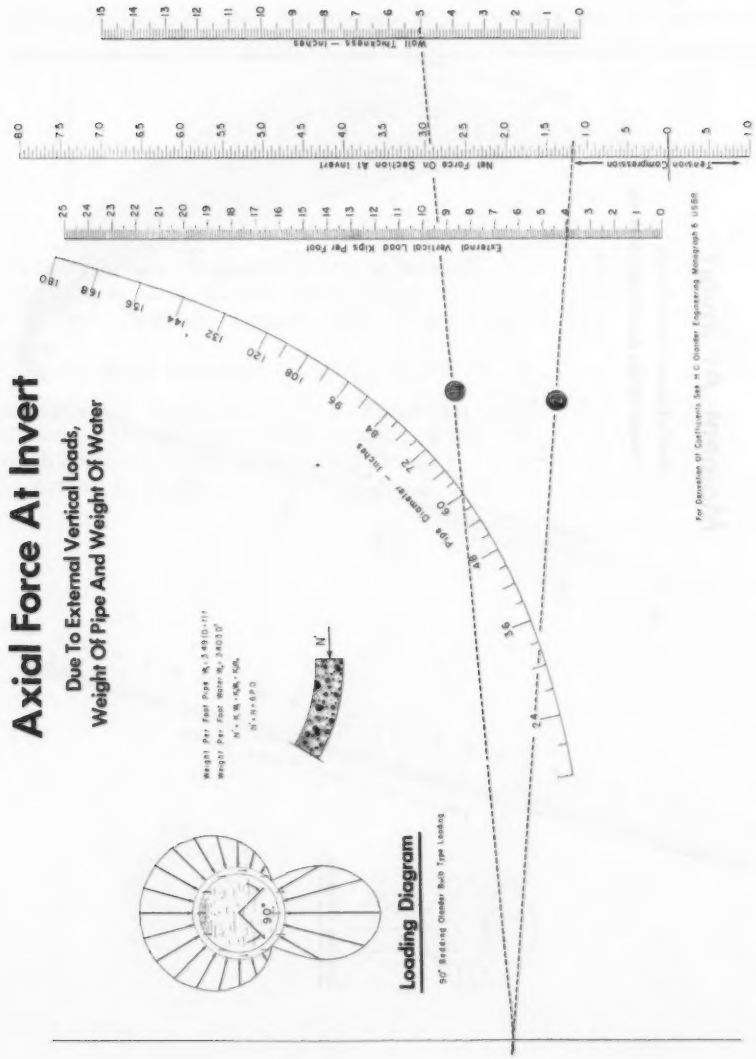



Axial Force At Crown
Due To External Vertical Loads,
Weight Of Pipe And Weight Of Water
Compressive Forces Are Positive
90°
N'
Loading Diagram
90° Bedding Cylinder Bulb Type Loading
Weight Per Foot Pipe W_p = 3.493 (D+1)!
Weight Per Foot Water W_w = .3403 D²
N' = 1.1 W_p + W_w + P_w
N' = N + 6 P D
For Derivation Of Coefficients See M C Cylinder
Engineering Monograph 6 USBR
Inside Diameter – Inches
144 132 120 108 96 84 72 60 48 36 24
External Vertical Load – Kips Per Foot
30 25 20 15 10 5 0
Net Force Over Section – Kips Per Foot
11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
Wall Thickness – Inches
0 5 10 15

Moment At Crown

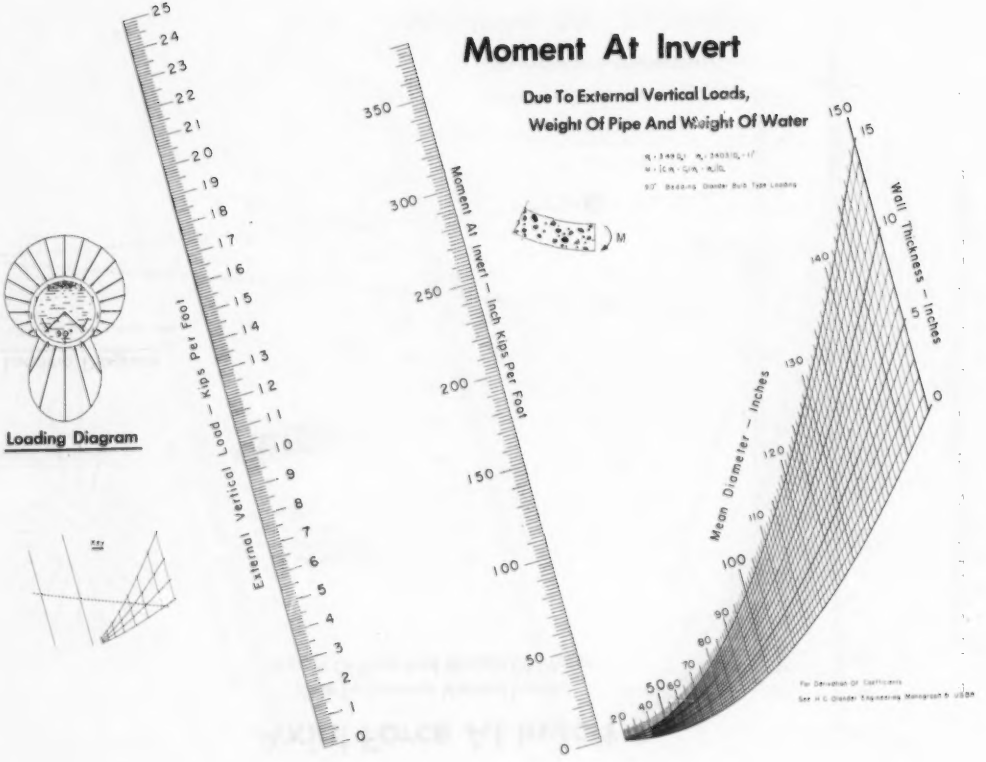
Due To External Vertical Loads,
Weight Of Pipe And Weight Of Water


90°
Loading Diagram
External Vertical Load – Kips Per Foot
Moment At Crown – Inch Kips Per Foot
Mean Diameter – Inches
Wall Thickness Inches
M
90° Bedding Clander Bulb Type Loading
For Derivation Of Coefficients
See H C Clander Engineering Monograph A USBR


Axial Force At Invert
Due To External Vertical Loads,
Weight Of Pipe And Weight Of Water
Loading Diagram
90° Bedding Ordeer Buck Type Loading
Pipe Diameter - Inches
Wall Thickness - Inches
Net Force On Section At Invert
Compression
Tension
External Vertical Load Kips Per Foot
For Detention Of Coefficients See H.C. Olander Engineering Monograph 5 USBR

Moment At Invert

Due To External Vertical Loads, Weight Of Pipe And Weight Of Water



Journal of the
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Proceedings of the American Society of Civil Engineers

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Note: Paper 2233 is part of the copyrighted Journal of the Pipeline Division, Proceedings of the American Society of Civil Engineers, Vol. 85, PL 3, October, 1959.

WATER DISTRIBUTION PROBLEMS SOLVED BY NETWORK CALCULATORS[a]

Closure by L. M. Haupt

L. M. HAUPT[1].—The prime purpose of the paper was to point out that any alternating current or direct current network calculator (or analyzer) may be used to solve either compressible or incompressible fluid distribution flow problems. There are now approximately 50 large a.c. calculators (with others on order) and several times that number of d.c. calculators in operation. It is hoped, also, that this paper will assist the operators of these laboratories by giving them the advantage of the author's experience and thus make possible studies of water distribution systems that otherwise might not be made.

The use of non-linear tungsten filament elements, that are either incandescent lamps or are custom built, speeds up the solution. It is only on a.c. calculators that an incandescent lamp coupled with a variable transformer may be made to reflect any desired value of resistance. This does require additional equipment. The results, however, have been very satisfactory.

As pointed out in the discussion the iterative adjustment of resistance is time consuming, but not to the extent that at first appears. An experienced operator may achieve a balance in a relatively short time. One advantage is that the flow-head loss relation may be made to follow any given imperical equation or curve with equal facility. It should be mentioned that even when non-linear resistors (such as tungsten filament lamps) are used the flow-head loss relation is checked before final reading.

Excessive power loss in a pipe section as an indication of a critical area was noted by serendipity, but it can be shown to be theoretically correct. Experience since this was noted has shown that "power loss" is of equal importance with "head loss" as a major design criteria. The addition of a wattmeter to any d.c. calculator makes possible the reading of this loss directly.

Inasmuch as the network calculator (analyzer) is a direct analogue computer as in the McIlroy Analyzer, it is also a basic design tool and should not be confused with digital computers and calculators or differential analyzers.

The author acknowledges the error in units in the published paper.

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a. Proc. Paper 1577, March, 1958, by L. M. Haupt.

1. Prof. of electrical eng., A & M College of Texas, College Station, Tex., and supervisor of the A-C Network Calculator, Texas A & M Research Foundation.

GILSONITE SOLIDS PIPE LINE[a]

Discussion by Arthur L. Collins

ARTHUR L. COLLINS,[1] M. ASCE.—The authors show by Fig. 3 the clear water pressure per 1000' and velocity in fps for the 6" pipe line. At 6 fps the friction loss is 7 psi or 16.2' of water. For the same velocity Hazen-Williams show 19.8 or about 20% difference with an H-W coefficient C of 140. What is happening at the terminal curves (1), (2) and (3)?

In a problem of this kind which deals with fluids containing solids a pressure recording gage system now described will reveal important information. This is illustrated by referring to the performance of the pipe line suction dredge. In the early 1880's the transportation of solids by pipe line began on a large scale. However the Patent Office records mentioned the pump as being used for this purpose in the 1840's.

The cutter of the dredge dislodges the soils under water, the pump elevates them by its suction and delivers them to the pipe line. The pump and pipe sizes up until about 1930 varied from about 12" to 24" but now are as large as 36". During the past 20 years a great many pumps 8" to 12" have been used on small yardage jobs such as cleaning reservoirs. These rigs are generally portable when partially dismantled and can be moved overland by truck.

It is mostly with the large pumps and pipe line that the writer has had an opportunity to study and analyze their hydraulic characteristics. The chart here records what happens in a short section of pipe during normal operations. Generally speaking line velocities will range between 16 and 22 fps. In the 20" line the minimum velocity considered practical appears to be about 13 fps. In the large pipes the C in Hazen-Williams will vary from 135 to 150. The horizontal pipe on shore is assembled from welded pipe sections about 15-1/2' long with the trailing end having a 12" "welded on" sleeve which tapers 1 ' to form a slip joint. The reduced diameter of the sleeve has a nozzle effect and increases the velocity about 10%. On the floating pontoon line the pipe sections are about 50' with bell and socket joints.

The chart submitted shows the pressure drop in a 26-1/2" pipe line of about 40' and located near the pump. The section is horizontal with leading and trailing piezometer taps. The conventional mercury type manometer with 24 hour chart is used. The line pressure is about 100 psi.

In the dredge operation the suction pipesmouth-piece, (inlet casting) traverses the channel in about 7 minutes. It then returns at the same speed but at a 4' lower level. The chart range is 60" of water differential. Reference No. 1 is at 21" which is the clear water friction loss and 1st stage

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a. Proc. Paper 1908, January, 1959, by E. F. Fulkerson and J. E. Rinne.
1. Cons. Engr., Berkeley 5, Calif.

flow. By coincidence the velocity is also 21 fps as having been determined by a velocity dye test. With this calibration the section is the equivalent of the Venturi. At No. 2, the friction reading has increased to 27''. The ration of 27 over 21 or 130% is due to the increase in friction. The extra 30% accounts for the weight of the load carried by the fluid. On the return trip across the channel the rate is 24 over 21 or 115% thus showing a load of but 15%. The pump operating at a constant rpm will maintain a constant line velocity of 21 fps under this 2nd flow stage. An observer near the pipe line can occasionally hear objects such as steel nuts and rocks ricochet by leaps and bounds along the pipe.

On the chart extreme pressure peaks occur about one hour apart or oftener. This is the 3rd stage to which no mathematical rule will apply. The upset here has been caused by a combination of conditions. They occur about 30' below the water surface when the suction pipe is at an angle which causes stagnation. The soil material is dense and the suction at the pump increases. The large pumps always have an inherent weakness due to the high perpheral speed of the impeller vane edge. The vane in "cutting" the flow develops a high vacuum on the vane surface. This is in addition to the suction lift registered on a vacuum gage at the pump intake flange. Although the vacuum at the pump flange is considered permissable according to the "specific speed" criteria the head-capacity-curve is actually in the "cutoff" range. This is due to the excessive cavitation.

Referring again to the authors data, 850 tons of slurry concentrate have been pumped with a concentration of 40% and concentrations up to 43%. What is the nature of the limitation? Is it abrupt or does it come on gradually?

The gilsonite itself has a specific weight of 1.04 and from the graph Fig. 3 the increase in friction parallels the clear water curve with only a few percent difference which is in keeping with the rule for sand pumping and even in the small pipe sizes.

In the large pipes for dredging the high value of C in H-W is surprising in view of the turbulence at the many pipe joints. It may be that planned turbulence at stated locations in the horizontal line as well as in an ascending grade will materially increase the efficiency of transportation.

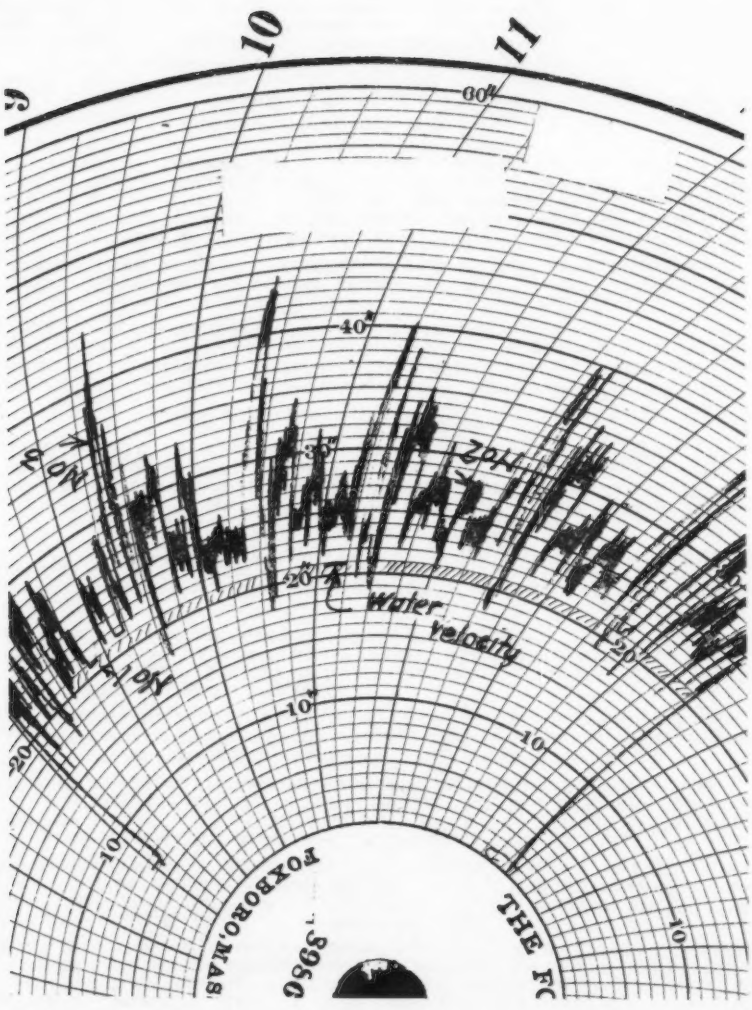

Fig. 3. Friction Loss in Dredge Pipe

PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Pipeline (PL), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways and Harbors (WW), divisions. Papers sponsored by the Department of Conditions of Practice are identified by the symbols (PP). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper number are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 1859 is identified as 1859 (HY7) which indicates that the paper is contained in the seventh issue of the Journal of the Hydraulics Division during 1958.

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OCTOBER: 1790(EM4), 1791(EM4), 1792(EM4), 1793(EM4), 1794(EM4), 1795(HW3), 1796(HW3), 1797(HW3), 1798(HW3), 1799(HW3), 1800(HW3), 1801(HW3), 1802(HW3), 1803(HW3), 1804(HW3), 1805(HW3), 1806(HY5), 1807(HY5), 1808(HY5), 1809(HY5), 1810(HY5), 1811(HY5), 1812(SM4), 1813(SM4), 1814(ST6), 1815(ST6), 1816(ST6), 1817(ST6), 1818(ST6), 1819(ST6), 1820(ST6), 1821(ST6), 1822(EM4), 1823(PO5), 1824(SM4), 1825(SM4), 1826(SM4), 1827(ST6)[c], 1828(SM4)[c], 1829(HW3)[c], 1830(PO5)[c], 1831(EM4)[c], 1832(HY5)[c].

NOVEMBER: 1833(HY6), 1834(HY6), 1835(SA6), 1836(ST7), 1837(ST7), 1838(ST7), 1839(ST7), 1840(ST7), 1841(ST7), 1842(SU3), 1843(SU3), 1844(SU3), 1845(SU3), 1846(SU3), 1847(SA6), 1848(SA6), 1849(SA6), 1850 (SA6), 1851(SA6), 1852(SA6), 1853(SA6), 1854(ST7), 1855(SA6)[c], 1856(HY6)[c], 1857(ST7)[c], 1858(SU3)[c].

DECEMBER: 1859(HY7), 1860(IR4), 1861(IR4), 1862(IR4), 1863(SM5), 1864(SM5), 1865(ST8), 1866(ST8), 1867 (ST8), 1868(PP1), 1869(PP1), 1870(PP1), 1871(PP1), 1872(PP1), 1873(WW5), 1874(WW5), 1875(WW5), 1876 (WW5), 1877(CP2), 1878(ST8), 1879(ST8), 1880(HY7)[c], 1881(SM5)[c], 1882(ST8)[c], 1883(PP1)[c], 1884(WW5)[c], 1885(CP2)[c], 1886(PO6), 1887(PO6), 1888(PO6), 1889(PO6), 1890(HY7), 1891(PP1).

VOLUME 85 (1959)

JANUARY: 1892(AT1), 1893(AT1), 1894(EM1), 1895(EM1), 1896(EM1), 1897(EM1), 1898(EM1), 1899(HW1), 1900(HW1), 1901(HY1), 1902(HY1), 1903(HY1), 1904(HY1), 1905(PL1), 1906(PL1), 1907(PL1), 1908(PL1), 1909(ST1), 1910(ST1), 1911(ST1), 1912(ST1), 1913(ST1), 1914(ST1), 1915(ST1), 1916(AT1)[c], 1917(EM1)[c], 1918(HW1)[c], 1919(HY1)[c], 1920(PL1)[c], 1921(SA1)[c], 1922(ST1)[c], 1923(EM1), 1924(HW1), 1925(HW1), 1926 (PL1), 1927(HW), 1928(HW1), 1929(SA1), 1930(SA1), 1931(SA1), 1932(SA1).

FEBRUARY: 1933(HY2), 1934(HY2), 1935(HY2), 1936(SM1), 1937(SM1), 1938(ST2), 1939(ST2), 1940(ST2), 1941(ST2), 1942(ST2), 1943(ST2), 1944(ST2), 1945(HY2), 1946(PO1), 1947(PO1), 1948(PO1), 1949(PO1), 1950(HY2)[c], 1951(SM1)[c], 1952(ST2)[c], 1953(PO1)[c], 1954(CO1), 1955(CO1),1956(CO1),1957(CO1), 1958(CO1), 1959(CO1).

MARCH: 1960(HY3), 1961(HY3), 1962(HY3), 1963(IR1), 1964(IR1), 1965(IR1), 1966(IR1), 1967(SA2), 1968(SA2), 1969(ST3), 1970(ST3), 1971(ST3), 1972(ST3), 1973(ST3), 1974(ST3), 1975(ST3), 1976(WW1), 1977(WW1), 1978(WW1), 1979(WW1), 1980(WW1), 1981(WW1), 1982(WW1), 1983(WW1), 1984(SA2), 1985(SA2)[c], 1986 (IR1)[c], 1987(WW1)[c], 1988(ST3)[c], 1989(HY3)[c].

APRIL: 1990(EM2), 1991(EM2), 1992(EM2), 1993(HW2), 1994(HY4), 1995(HY4), 1996(HY4), 1997(HY4), 1998 (SM2), 1999(SM2), 2000(SM2), 2001(SM2), 2002(ST4), 2003(ST4), 2004(ST4), 2005(ST4), 2006(PO2), 2007 (HW2)[c], 2008(EM2)[c], 2009(ST4)[c], 2010(SM2)[c], 2011(SM2)[c], 2012(HY4)[c], 2013(PO2)[c].

MAY: 2014(AT2), 2015(AT2), 2016(AT2), 2017(HY5), 2018(HY5), 2019(HY5), 2020(HY5), 2021(HY5), 2022(HY5), 2023(PL2), 2024(PL2), 2025(PL2), 2026(PP1), 2027(PP1), 2028(PP1), 2029(PP1), 2030(SA3), 2031(SA3), 2032(SA3), 2033(SA3), 2034(ST5), 2035(ST5), 2036(ST5), 2037(ST5), 2038(PL2), 2039(PL2), 2040(AT2)[c]. 2041(PL2)[c], 2042(PP1)[c], 2043(ST5)[c], 2044(SA3)[c], 2045(HY5)[c], 2046(PP1), 2047(PP1).

JUNE: 2048(CP1), 2049(CP1), 2050(CP1), 2051(CP1), 2052(CP1), 2053(CP1), 2054(CP1), 2055(CP1), 2056 (HY6), 2057(HY6), 2058(HY6), 2059(IR2), 2060(IR2), 2061(PO3), 2062(SM3), 2063(SM3), 2064(SM3), 2065 (ST6), 2066(WW2), 2067(WW2), 2068(WW2), 2069(WW2), 2070(WW2), 2071(WW2), 2072(CP1)[c], 2073(IR2)[c], 2074(PO3)[c], 2075(ST6)[c], 2076(HY6)[c], 2077(SM3)[c], 2078(WW2)[c].

JULY: 2079(HY7), 2080(HY7), 2081(HY7), 2082(HY7), 2083(HY7), 2084(HY7), 2085(HY7), 2086(SA4), 2087 (SA4), 2088(SA4), 2089(SA4), 2090(SA4), 2091(EM3), 2092(EM3), 2093(EM3), 2094(EM3), 2095(EM3), 2096 (EM3), 2097(HY7)[c], 2098(SA4)[c], 2099(EM3)[c], 2100(AT3), 2101(AT3), 2102(AT3), 2103(AT3), 2104(AT3), 2105(AT3), 2106(AT3), 2107(AT3), 2108(AT3), 2109(AT3), 2110(AT3), 2111(AT3), 2112(AT3), 2113(AT3), 2114(AT3), 2115(AT3), 2116(AT3), 2117(AT3), 2118(AT3), 2119(AT3), 2120(AT3), 2121(AT3), 2122(AT3), 2123(AT3), 2124(AT3), 2125(AT3).

AUGUST: 2126(HY8), 2127(HY8), 2128(HY8), 2129(HY8), 2130(PO4), 2131(PO4), 2132(PO4), 2133(PO4), 2134 (SM4), 2135(SM4), 2136(SM4), 2137(SM4), 2138(HY8)[c], 2139(PO4)[c] 2140(SM4)[c].

SEPTEMBER: 2141(CO2), 2142(CO2), 2143(CO2), 2144(HW3), 2145(HW3), 2146(HW3), 2147(HY9), 2148(HY9), 2149(HY9), 2150(HY9), 2151(IR3), 2152(ST7)[c], 2153(IR3), 2154(IR3), 2155(IR3), 2156(IR3), 2157(IR3), 2158 (IR3), 2159(IR3), 2160(IR3), 2161(SA5), 2162(SA5), 2163(ST7), 2164(ST7), 2165(SU1), 2166(SU1), 2167(WW3), 2168(WW3), 2169(WW3), 2170(WW3), 2171(WW3), 2172(WW3), 2173(WW3), 2174(WW3), 2175(WW3), 2176 (WW3), 2177(WW3), 2178(CO2)[c], 2179(IR3)[c], 2180(HW3)[c], 2181(SA5)[c], 2182(HY9)[c], 2183(SU1)[c], 2184 (WW3)[c], 2185(PP2)[c], 2186(ST7)[c], 2187(PP2), 2188(PP2).

OCTOBER: 2189(AT4), 2190(AT4), 2191(AT4), 2192(AT4), 2193(AT4), 2194(EM4), 2195(EM4), 2196(EM4), 2197(EM4), 2198(EM4), 2199(EM4), 2200(HY10), 2201(HY10), 2202(HY10), 2203(PL3), 2204(PL3), 2205 (PL3), 2206(PO5), 2207(PO5), 2208(PO5), 2209(PO5), 2210(SM5), 2211(SM5), 2212(SM5), 2213(SM5), 2214 (SM5), 2215(SM5), 2216(SM5), 2217(SM5), 2218(ST8), 2219(ST8), 2220(EM4), 2221(ST8), 2222(ST8), 2223 (ST8), 2224(HY10), 2225(HY10), 2226(PO5), 2227(PO5), 2228(PO5), 2229(ST8), 2230(EM4), 2231(EM4), 2232(AT4)[c], 2233(PL3)[c], 2234(EM4)[c], 2235(HY10)[c], 2236(SM5)[c], 2237(ST8)[c], 2238(PO5)[c], 2239(ST8), 2240 (PL3).

c. Discussion of several papers, grouped by divisions.

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VOLUME 85 PART 2

Your attention is invited

NEWS OF THE PIPELINE DIVISION OF ASCE

JOURNAL OF THE PIPELINE DIVISION
PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

DIVISION ACTIVITIES

PIPELINE DIVISION

Proceedings of the American Society of Civil Engineers

NEWS

October, 1959

WASHINGTON MEETING

The annual ASCE convention at Washington, D.C., in the Hotel Statler on October 19-21, includes the following papers for the Monday program: "A Pipe Within a Pipe" by James C. Fisher of Consolidated Edison Co. of New York; "Gas Outage Brings Crises to Portland, Oregon" by E. D. Rowan of Northwest Natural Gas Company, Portland, Oregon; "Why and How of Underground Storage" by Richard H. Fulton of Ball Associates, Washington, D.C.; "Spanish Air Bases Fuel Pipeline, Pump Stations, Terminals" by Commander Allegrone CEC USN, Navy Dept., Washington, D.C.; "Developing a Dream Into a Reality in a Nation of Private Enterprise" by F. E. Stanley, Chairman of the Board of Directors and President of the Houston Corporation, St. Petersburg, Fla.; "Preliminary Planning, Economics and Regulatory Hurdles - Construction Planning of the Natural Gas Pipeline of Houston, Texas, Gas and Oil Corporation" by O. Paul Herzig, V.P.-Engineering, The Houston Corporation, St. Petersburg, Fla.

On Tuesday, a trip to attend Federal Power Commission hearings in progress, with lunch at the F.P.C. cafeteria, followed by a visit to the Securities and Exchange Commission, is scheduled with speakers on the following subjects; for the F.P.C.: "The Commission's Responsibilities Under the Natural Gas Act" by Carl T. Kallina, Chief of the Bureau of Rates & Gas Certificates; "The Issuance of Certificates of Public Convenience and Necessity" by Olof W. Nelson, Asst. Chief of Bureau of Rates & Gas Certificates; "Rates and Particularly Natural Gas Pipeline Rate Matters" by Louis Zanoff, Asst. Chief of Bureau of Rates & Gas Certificates; "The Commission's Electric Power Functions" by Frank L. Adams, Chief of Bureau of Power; "The Commission's Legal Functions" by Robert L. Russell, Assistant General Counsel; and "The Commission's Accounting Functions" by Russell C. Rainwater, Chief Accountant. For the S.E.C.: "The Functions and Operations of The S.E.C." by Walter J. Costello, Engineer, and Maxwell Kaufman, Branch Chief Division of Corporation

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Finance; and "The Functions and Operations of The S.E.C. Pertaining to Pipelines" by J. Arnold Pines, Chief Financial Analyst and Leon H. Ware, Valuation Engineer, Division of Corporate Regulation.

The Wednesday afternoon program concludes with pipeline location discussions including "The Use of Tellurometer in Route Surveys" by Floyd Hough, Geodetic Consultant, Washington, D.C.

NEW ORLEANS MEETING

The theme "Marine Pipelines" is being used for the New Orleans convention program at the Jung Hotel, March 9-10-11. Papers will be presented on "Unusual Design and Construction Problems of Marine Pipelines" by Southern Natural Gas Co.; "Special Right-of-Way Conditions Encountered in the Southern Louisiana Area" by Tennessee Gas Pipeline Co.; "Molten Sulphur Line" by Freeport Sulphur Co.; "Corrosion Control of Marine Pipelines" by Cathodic Protection Service; "Coating Innovations for Marine Pipelines" by Brown & Root; "What We Know and Don't Know About Overcoming Buoyancy on Marine Lines" by Transcontinental Gas Pipe Line Corp.; "Mississippi River Crossings and Their Various Designs Due to Locations and Conditions" by Pyburn & Odom of Baton Rouge. The field trip on Tuesday includes a visit to a coating yard and to off-shore operations.

OTHER 1960 MEETINGS

The Pipeline Division is participating in the Reno convention June 20-24, 1960, in a program of two or more jointly-sponsored sessions with the Power and the Hydraulics divisions with a field trip to nearby projects, such as the 2500-ft.hd. penstock of Pacific Gas & Electric Co. or the pioneer hi-head aqueduct to Virginia City. A program for the annual convention in Boston, October 9-14, 1960, is now in the planning stage.

COMMITTEE ON PIPELINE CROSSINGS OF RAILROADS AND HIGHWAYS

The final draft of the proposed Specifications is being submitted to the various organizations for approvals prior to final submission to the A.S.A. B31 Subcommittee 8 for adoption as a standard.

In order to substantiate certain design assumptions and theories on which design strength criteria are based in the Specification, a research program has been started to obtain this needed factual information. This data includes the deflection and longitudinal sag of casings and the modulus of passive resistivity of soils. Secondary data will be obtained by the American Gas Association PAR Research Committee Project NG-22. Program Director is Dr. Merlin G. Spangler of Iowa State College.

The first field installation has been started by Transcontinental Gas Pipe Line Corporation under the L & N Railroad Company main line in the vicinity of Birmingham, Alabama. This is a dummy casing installation, without carrier pipe, or three large-diameter casings about 25 feet on centers. A laboratory investigation is also being conducted.

E. B. Anderson, Asst. Chief Engineer of Algonquin Gas Transmission Co. of Boston, Mass., has been appointed to the Steering Committee. Algonquin will make available to the committee their special study and research work initiated by them at Massachusetts Institute of Technology.

COMMITTEE ON PIPELINE PLANNING

Pipeline Planning was re-organized by Chairman Larry Shea at a meeting in connection with the Cleveland convention last May. The members now appointed include a Control Group of Chairman Carter L. Shea, Shell Oil Co., Indianapolis, Lewis E. Hoffmann of Henry Hendon & Associates, Birmingham, David R. Jenkins of the University of Michigan, Ann Arbor, Mercel J. Shelton of Koebig & Koebig, San Diego, and Joseph B. Spangler of Transcontinental Gas Pipe Line Corp., Houston; with other committee members Benjamin F. Caffey of Seeler & Associates, Los Angeles, Dr. Pietro Celestre of Rome, Italy, S. Mark Davidson of Thompson Pipe & Steel Co., Denver, Clarence W. E. Davies of Alco Products, Dunkirk, N.Y., Henry H. List of Shell Pipe Line Co., Houston, Gerald L. Meck of East Oil Gas Co., Lima, Ohio, Alexander C. McLaughlin of American Oil Co., Long Beach, Jack W. Pierce of Southern California Gas Co., Los Angeles, John A. Shaw of Lock Joint Pipe Co., East Orange, Adam Sommer of Alco Products, Dunkirk, N.Y., William Wallace of Marcoil Technical Service, London, England, and Samuel A. Wilson of Bethlehem Steel Co., Bethlehem, Pa.

Next meeting is scheduled in Washington, D.C., on October 18. Task Committees will be organized. Subjects being considered for studies include Economic Development Studies, Pipe Coatings - Internal and External, Obtaining Greater Accuracy in Estimating Future Peak Loads in Residential and Commercial Integrative Areas, Use of Thin-Wall Pipe in Low Pressure Gas Distribution Systems, Automatic Computing in Design and Planning—investigation into available programs and new methods of analysis, Cathodic Protection, Interface Detection Improvements, Hot Oil Line Design Procedures, Ore Transportation by Submarine Pipeline, and Storage of Pipeline Fluids.

COMMITTEE ON PIPELINE INSTALLATION

Chairman Herb Chapton organized the Committee on Pipeline Installation at the May 3 meeting in Cleveland. Committee members include a Control Group of Robert Rupley of Midwest Construction Co., Indianapolis and James H. Spracklen of Transcontinental Gas Pipe Line Corp., Houston; also, other members Jay J. Ball of Texas Eastern Transmission Corp., Shreveport, John G. Hendrickson of American Concrete Pressure Pipe Association, Chicago, Robert L. Schneider of Owens-Corning Fiberglas, Toledo, Joe Siegel, Dept. of Water & Power, Los Angeles, Francis J. Stastny of Texas Eastern Transmission Corp., Shreveport, James W. Wallace of Industrial Pipe Line Co., Baldwin Park, Calif., and Arthur B. Wilder of National Tube, U. S. Steel, Pittsburgh, Pa.

Task Groups will be organized at the Washington, D.C., meeting on October 18 with studies proposed on Problems in Field Welding of Joints of X56 and Higher Grades of Line Pipe, Backfill Material and Backfilling for

Pipelines, New Construction Techniques & Equipment, Proof Testing of New Lines, Pumping & Compressor Station Installation Problems.

The Task Committee on Pipeline Flotation was organized on May 3 with the following representatives of companies: Chairman Robert A. Rait of Humble Oil & Refining Co., Houston and a Control Group of Prof. Albert J. Bonar, University of Houston, Henry H. List of Shell Pipe Line Co., Houston, Bramlette McClelland of McClelland Engineers, Houston, Leo M. Odom, Consulting Engineer of Baton Rouge, La., and Joseph B. Spangler of Transcontinental Gas Pipe Line Corp., Houston; with other members Jay J. Ball of Texas Eastern Transmission Corporation, Shreveport, Robert J. Baldwin and Maurice G. Bechtol of Tennessee Gas Pipeline Co., Houston, Herbert J. Chapton of Los Angeles Water System, James C. Fisher of Consolidated Edison Co. of New York, Inc., William P. Heineman of United Gas Pipe Line Co., Shreveport, William T. Ivey of Southern Natural Gas Co., Birmingham, Earl C. Kirchner of American Louisiana Pipe Line Co., Detroit, Robert L. Rupley of Midwest Construction Co., Indianapolis, Carter L. Shea of Shell Oil Co., Indianapolis, and James H. Spracklen of Transcontinental Gas Pipe Line Corp., Houston.

The main task is to obtain new engineering information on flotation and the correct weighting of large-sized pipelines in wet areas--a problem of interest to natural gas, oil, products, and water pipeline engineers.

A research program is being initiated to determine the extent of the factors that influence the stability of a pipeline with respect to flotation out of a trench in which the pipe is laid, subsequently filled with earth, and the backfill inundated. The forces tending to produce flotation are caused by displacement of the water and by the backfill in the trench. These are overcome by the weight of the pipeline (including contents, weight coating, anchoring, etc.), by the resultant of the effective pressure of backfill resting on top of the pipe, and by the summation of shearing stresses along possible planes of rupture in the backfill material. Evaluations are proposed by laboratory studies of large-scale model tests and by surveys of field performance.

Several committee meetings have been held and rapid progress is being made. Questionnaires to numerous companies and associations have been mailed out to obtain examples of methods used for determining negative buoyancy and factors used in actual installations. Individual replies to this questionnaire will be kept confidential and the summarizations prepared for publication will omit company and other identifying names. A bibliography of special reports, handbook data, technical magazine articles, and other data has been compiled, including a listing of companies who provide weights, anchors, and weight coatings.

Interim reports are being prepared for publication in the Pipeline Division JOURNAL.

COMMITTEE ON PIPELINE OPERATION & MAINTENANCE

Chairman Richard Garnjost of The Buckeye Pipe Line Co., Lima, Ohio, at the May 3 meeting in Cleveland, organized the new Committee on Pipeline Operation & Maintenance. His Control Group includes Kenneth W. Ahbol, Director of Maintenance Control, U.S. Naval Air Station, Key West, Gustave J. Angele, Sr., of Union Carbide Nuclear Co., Oak Ridge, Ray R. Berman of

Bendix Computer Division, Los Angeles, and committee members Ralph C. Hughes of Cosden Pipe Line Co., Big Springs, Texas, Fred Lee of Shell Pipe Line Co., Houston, Robert D. McClintock of American Louisiana Pipe Line Co., Detroit, and William T. Theis of Internal Pipe Line Maintenance Co., Odessa, Texas. Task groups will be assigned at the October 18 meeting in Washington. Subjects being considered for task group work include Operating & Maintenance Cost Studies, Techniques for Line Replacement and and Repair, New Developments in Operating Techniques, Computer Application to Pipeline Operation, and Internal Coating of Lines in Operation with the Effects on Throughput and Cost Reductions.

LOS ANGELES PIPELINE GROUP

The Los Angeles Section formed a Los Angeles Pipeline Group of 26 members with monthly meetings. Officers elected are Chairman Jack W. Pierce of Southern California Gas Co., Vice Chairman Joe Siegel of the Los Angeles Department of Water and Power, and Secretary-Treasurer Kenneth F. Miller of American Pipe and Construction Co. This group was organized last June by Herbert J. Chapton, Chairman of the Committee on Pipeline Installation, who found that the group fills a need contemplated since the Pipeline Division was authorized three years ago. Considerable interest has been generated with regular meetings which include joint meetings of the Pipeline and other local groups.

OTHER COMMITTEE PERSONNEL CHANGES

David R. Williams, Jr., Vice President of Williams Brothers Co. of Tulsa and New York, was appointed by the Committee on Division Activities as a member of the Executive Committee of the Pipeline Division—this appointment effective October 21, 1959, with term running until October of 1963. Fred C. Culpepper, Jr. of Ford, Bacon & Davis, Inc., Monroe, Louisiana, is Chairman of the Executive Committee for 1959-1960 replacing Chairman Arthur E. Poole. Donald E. Adams, Vice President, The Hallen Construction Co., Springfield, Mass., is replacing Secretary Joseph B. Spangler who resigned from the Executive Committee to devote more time to technical task committee work.

Professor David R. Jenkins of the University of Michigan, Ann Arbor, is the new Chairman of the Committee on Publications replacing Professor Robert D. Kersten of Oklahoma State University, Stillwater, Okla. Prof. Kersten resigned as Chairman due to absence from Stillwater for a period of about a year. He was granted a Standard Oil Foundation fellowship to do graduate work in fluid mechanics at Northwestern University, Evanston, Illinois. He will continue as a committee worker of the Committee on Publications and the Committee on Pipeline Flow.

Herbert J. Chapton, Products Design Engineer of the Los Angeles Water System, is a new member of the Committee on Session Programs. He is assisting with the Reno convention program next June, which program details are being arranged by John R. Teerink, supervising hydraulic engineer of the California Division of Water Resources.

CODE FOR PRESSURE PIPING (ASA B31)

The Gas Transmission and Distribution Piping Systems (Section 8 of the Code for Pressure Piping) sponsored by the A.S.M.E. has been revised as ASA B31.8-1958 and was published in May 1959. This is a revision of B31.8-1955 and consists primarily in rewording of various paragraphs (mentioned in our "Newsletter" of March, 1958 of action taken in Case No. 24) in order to clarify the intent of the Code.

One specific change is as follows: Whereas formerly, when a standard was incorporated into the Code by reference, the use of the latest published revision was intended; according to this revision of Section 8, only the revision listed in Appendixes A and B is to be used now.

EARLY TRANSACTIONS VOLUMES OBTAINABLE

The feasibility of reproducing the first ten volumes of ASCE Transactions (1872-1881) has been studied. It has been decided that these historic volumes could be reproduced at a cost that would permit a top price of $150 for the ten-volume set. If more than 100 engineers, or libraries, indicate an interest in obtaining such a set, the project will be undertaken. If the endeavor is successful, other rare volumes of Transactions will be reprinted.

Engineers interested in obtaining the ten-volume set should write to the Executive Secretary of ASCE, 33 West 39th Street, New York 18, N. Y.

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Committee chairmen are urged to schedule their committee meetings to take advantage of the budget provisions for their meetings—travel expense reimbursement can be requested for the authorized control groups of not more than 5 members.

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J. B. Spangler

Newsletter Editor